US007146446B2

(12) **United States Patent**
Chu

(10) **Patent No.: US 7,146,446 B2**
(45) **Date of Patent: Dec. 5, 2006**

(54) **MULTIPLE MODULE COMPUTER SYSTEM AND METHOD**

(75) Inventor: **William W. Y. Chu**, Los Altos, CA (US)

(73) Assignee: **Acqis Technology, Inc.**, Mountain View, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 18 days.

(21) Appl. No.: **11/113,401**

(22) Filed: **Apr. 22, 2005**

(65) **Prior Publication Data**

US 2005/0195575 A1 Sep. 8, 2005

Related U.S. Application Data

(63) Continuation of application No. 10/772,214, filed on Feb. 3, 2004, which is a continuation of application No. 09/569,758, filed on May 12, 2000, now Pat. No. 6,718,415.

(60) Provisional application No. 60/134,122, filed on May 14, 1999.

(51) **Int. Cl.**
G06F 13/00 (2006.01)

(52) **U.S. Cl.** **710/301**; 710/313; 710/315; 710/63; 710/72; 709/227; 709/248

(58) **Field of Classification Search** 710/305–315, 710/300–304, 62–64, 72–73; 709/214, 217, 709/219, 226, 227
See application file for complete search history.

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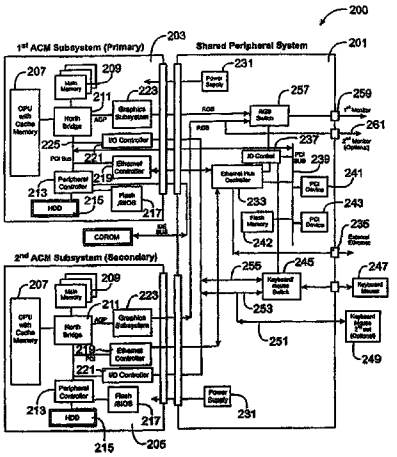
Assistant Examiner—Raymond N Phan
(74) *Attorney, Agent, or Firm*—Townsend and Townsend and Crew LLP

(57) **ABSTRACT**

A computer system for multi-processing purposes. The computer system has a console comprising a first coupling site and a second coupling site. Each coupling site comprises a connector. The console is an enclosure that is capable of housing each coupling site. The system also has a plurality of computer modules, where each of the computer modules is coupled to a connector. Each of the computer modules has a processing unit, a main memory coupled to the processing unit, a graphics controller coupled to the processing unit, and a mass storage device coupled to the processing unit. Each of the computer modules is substantially similar in design to each other to provide independent processing of each of the computer modules in the computer system.

80 Claims, 9 Drawing Sheets



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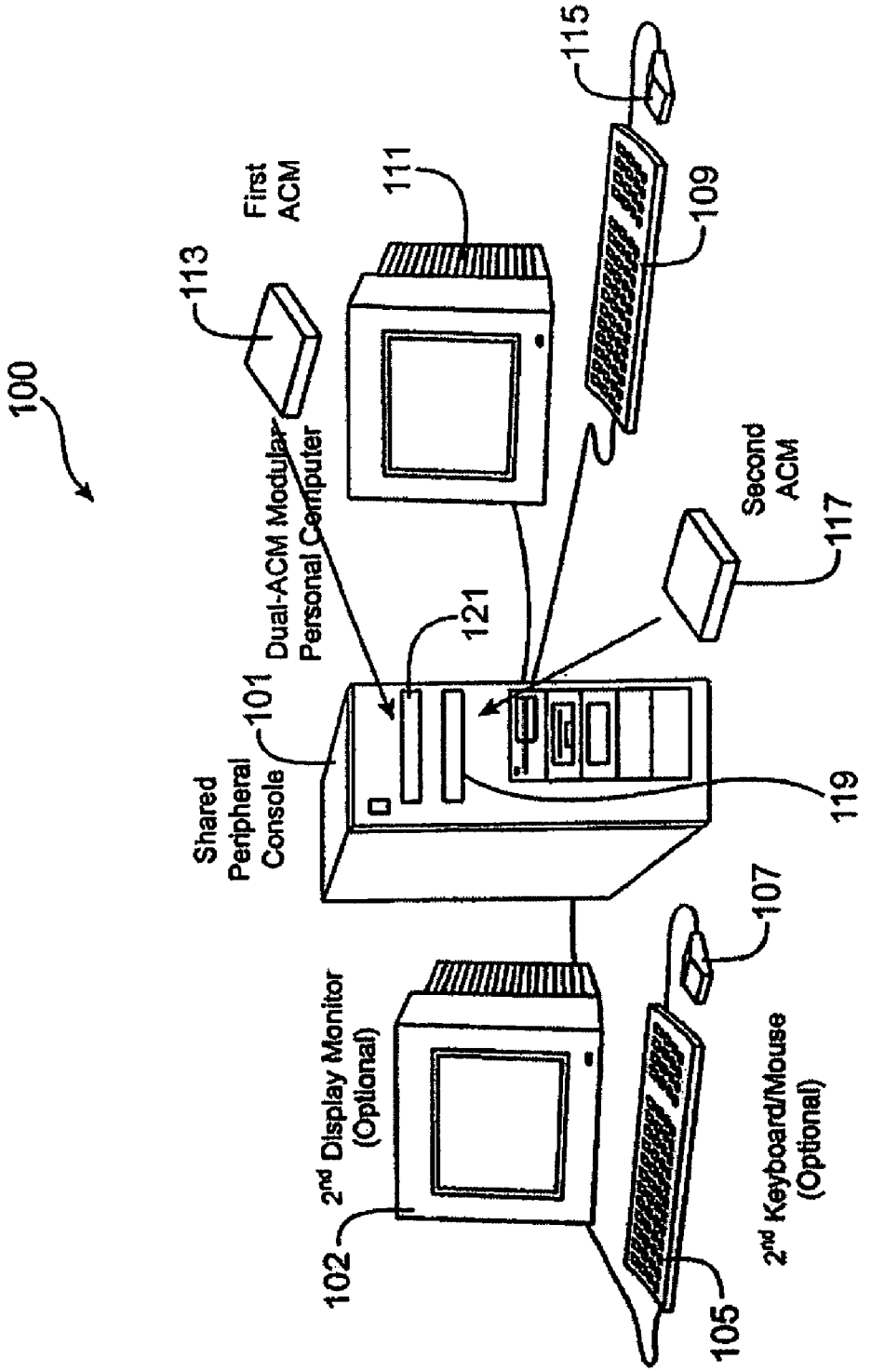
100
Dual-ACM Modular Personal Computer
Shared Peripheral Console
First ACM
Second ACM
2nd Display Monitor (Optional)
2nd Keyboard/Mouse (Optional)
101
102
105
107
109
111
113
115
117
119
121

FIG. 1

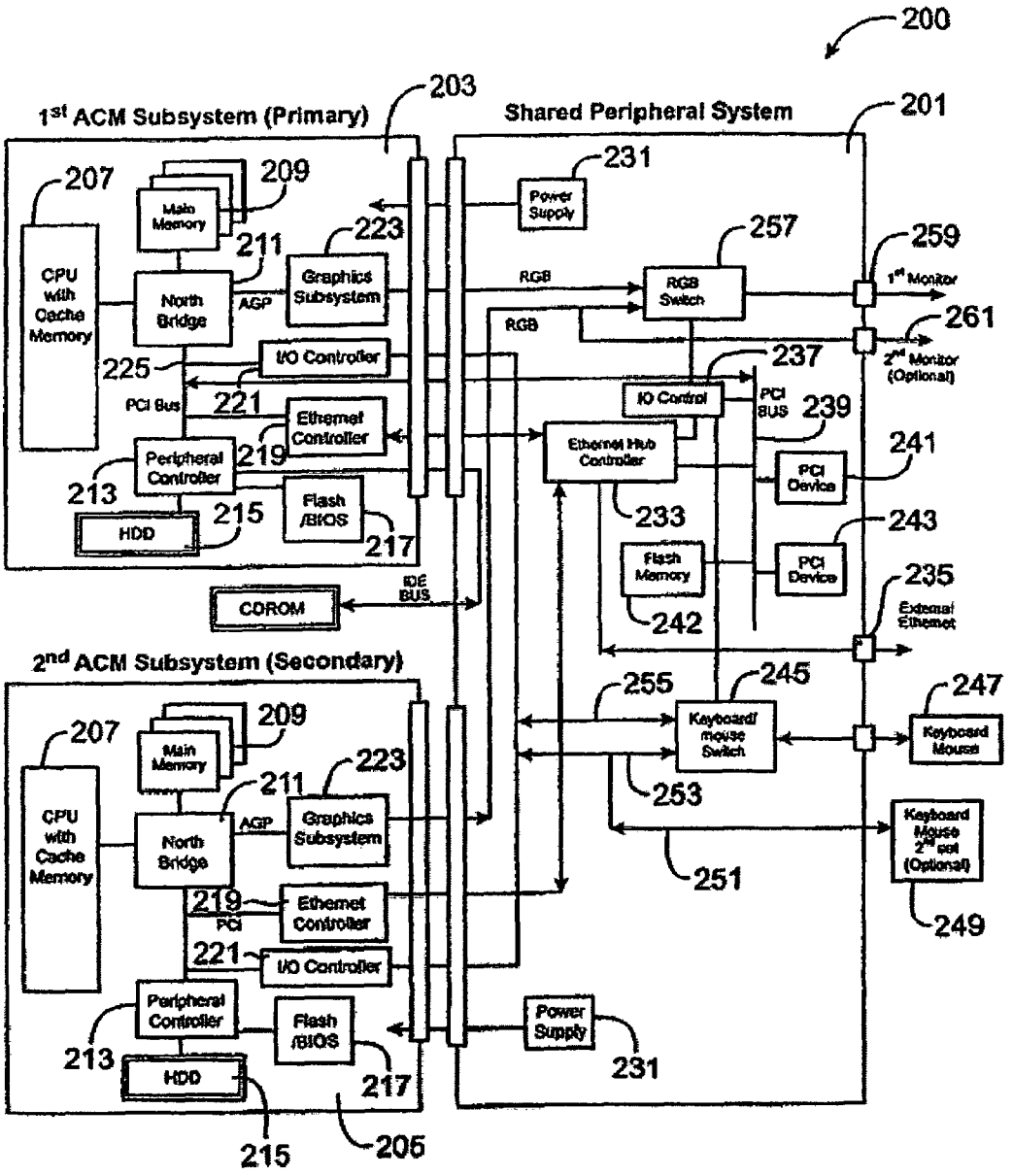
200
1st ACM Subsystem (Primary)
203
Shared Peripheral System
201
207
209
Main Memory
211
223
CPU with Cache Memory
North Bridge
AGP
Graphics Subsystem
225
I/O Controller
PCI Bus
221
Ethernet Controller
219
Peripheral Controller
213
HDD
215
Flash /BIOS
217
IDE BUS
CDROM
231
Power Supply
257
RGB
RGB Switch
259
1st Monitor
261
2nd Monitor (Optional)
237
I/O Control
PCI BUS
239
Ethernet Hub Controller
241
PCI Device
233
243
Flash Memory
242
PCI Device
235
External Ethernet
2nd ACM Subsystem (Secondary)
255
245
247
Keyboard/ mouse Switch
Keyboard Mouse
253
Keyboard Mouse 2nd set (Optional)
251
249
PCI
Power Supply
231
205

FIG. 2

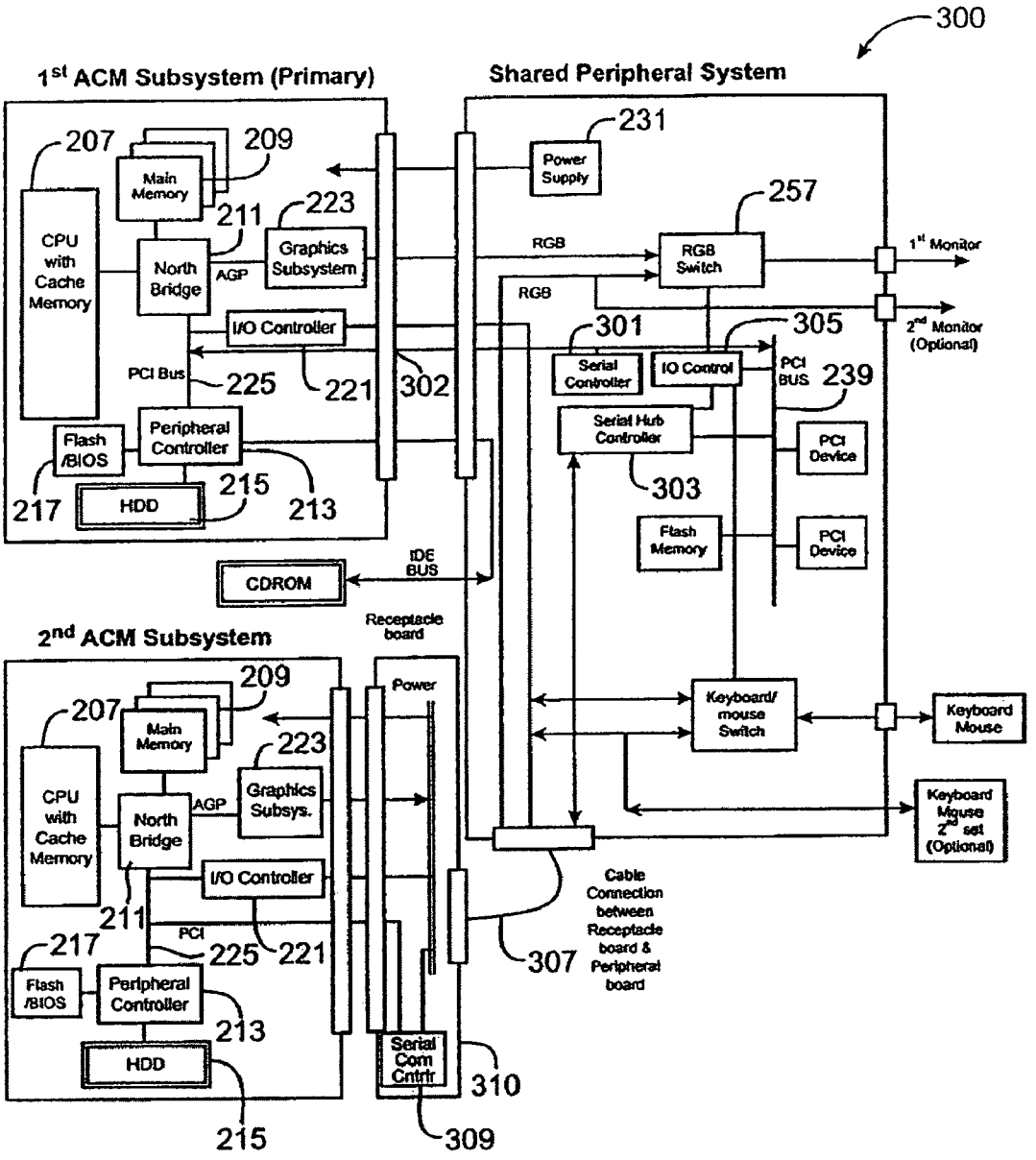
300
1st ACM Subsystem (Primary)
Shared Peripheral System
207
209
Main Memory
211
223
CPU with Cache Memory
North Bridge
AGP
Graphics Subsystem
I/O Controller
PCI Bus
225
221
302
Flash /BIOS
Peripheral Controller
217
HDD
215
213
231
Power Supply
257
RGB
RGB Switch
1st Monitor
RGB
2nd Monitor (Optional)
301
305
Serial Controller
IO Control
PCI BUS
239
Serial Hub Controller
PCI Device
303
Flash Memory
PCI Device
IDE BUS
CDROM
Receptacle board
2nd ACM Subsystem
209
207
Main Memory
223
Power
Keyboard/ mouse Switch
Keyboard Mouse
CPU with Cache Memory
AGP
North Bridge
Graphics Subsys.
Keyboard Mouse 2nd set (Optional)
I/O Controller
211
PCI
217
225
221
Cable Connection between Receptacle board & Peripheral board
307
Flash /BIOS
Peripheral Controller
213
HDD
Serial Com Cntrlr
310
215
309

FIG. 3

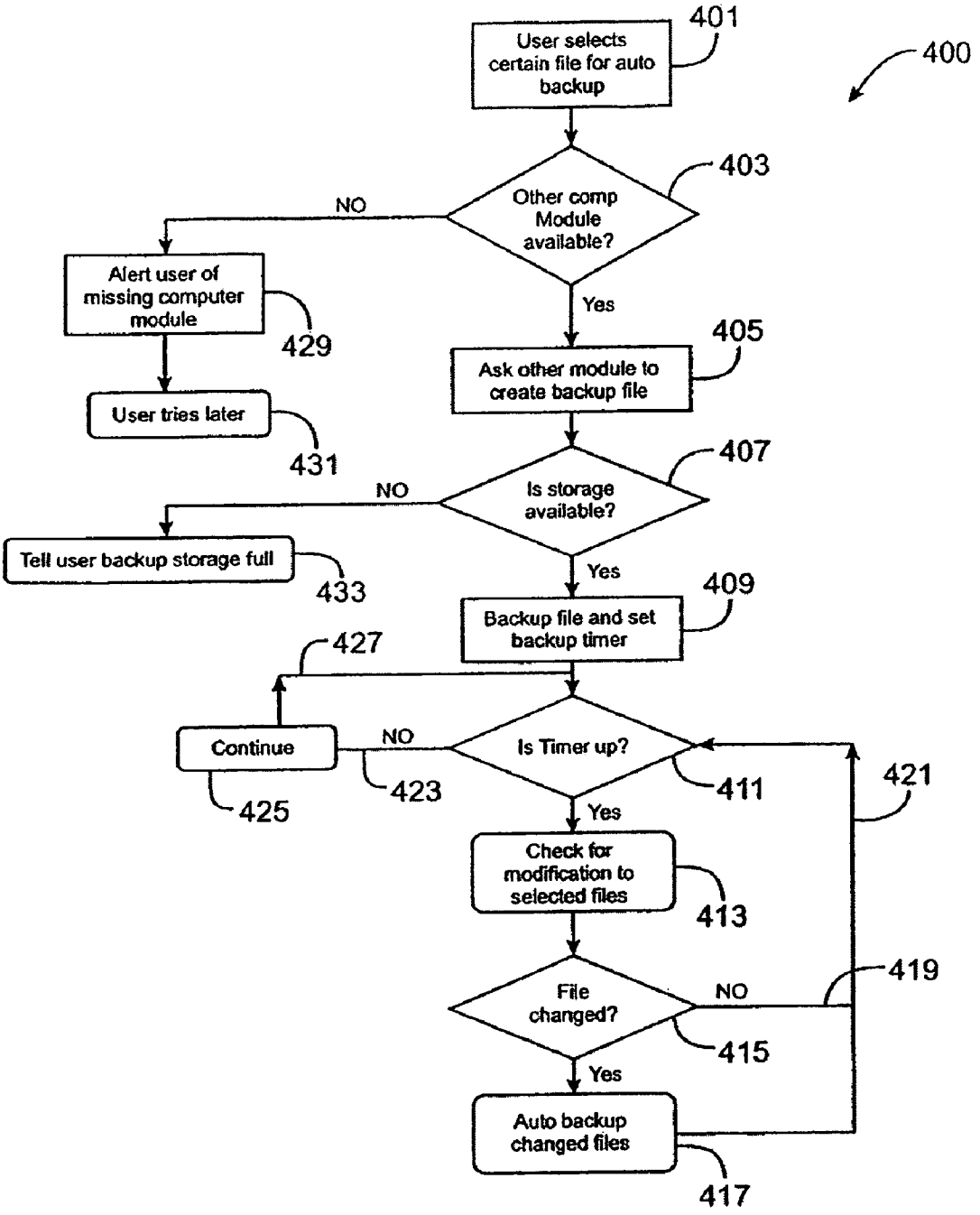
400
401
User selects certain file for auto backup
403
Other comp Module available?
NO
Yes
Alert user of missing computer module
429
User tries later
431
405
Ask other module to create backup file
407
Is storage available?
NO
Tell user backup storage full
433
Yes
409
Backup file and set backup timer
427
Continue
425
NO
423
Is Timer up?
411
421
Yes
Check for modification to selected files
413
419
File changed?
NO
415
Yes
Auto backup changed files
417

FIG. 4

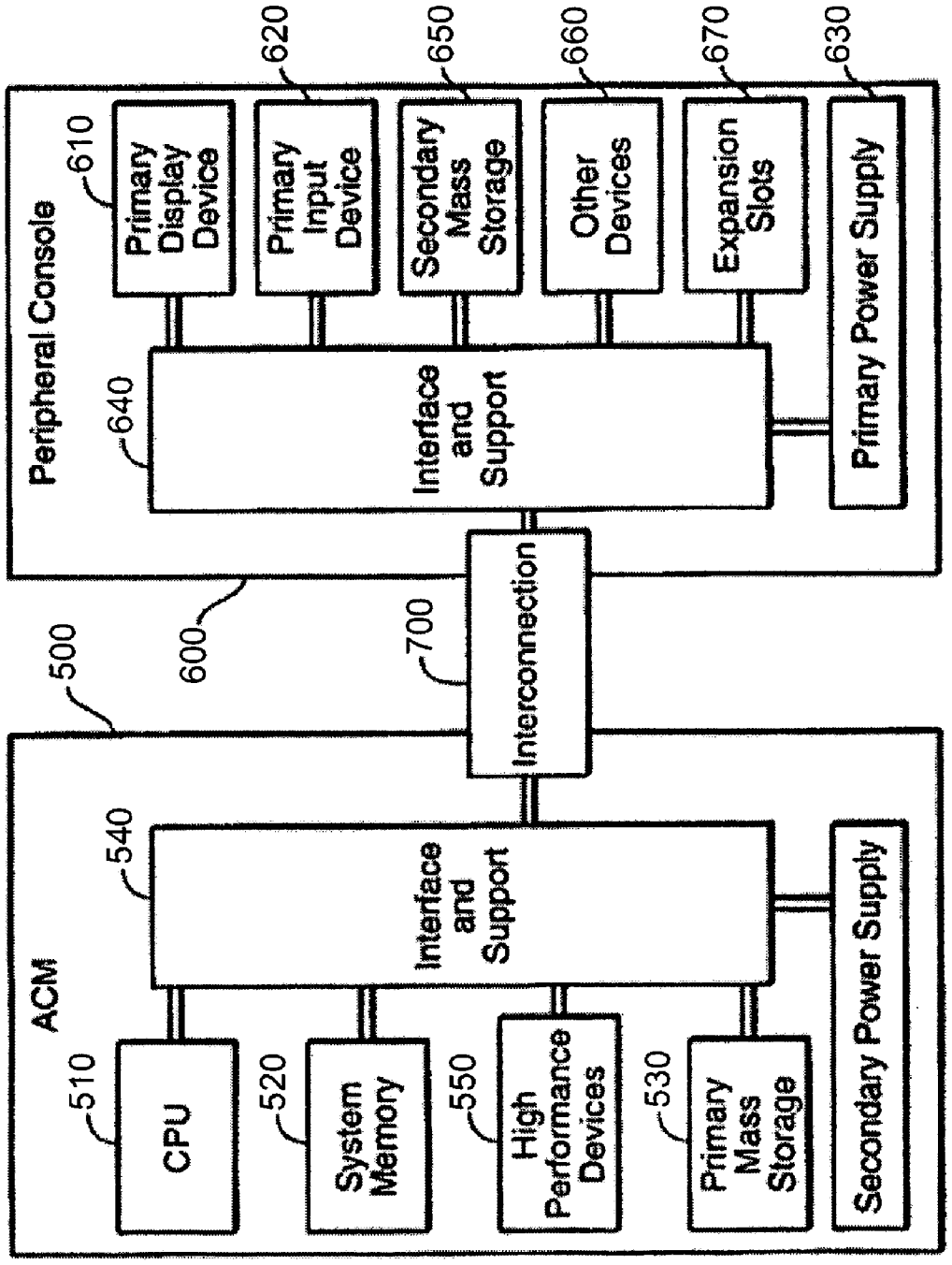
Peripheral Console
610
Primary Display Device
620
Primary Input Device
650
Secondary Mass Storage
660
Other Devices
670
Expansion Slots
630
Primary Power Supply
640
Interface and Support
600
700
Interconnection
500
ACM
540
Interface and Support
510
CPU
520
System Memory
550
High Performance Devices
530
Primary Mass Storage
Secondary Power Supply

FIG. 5

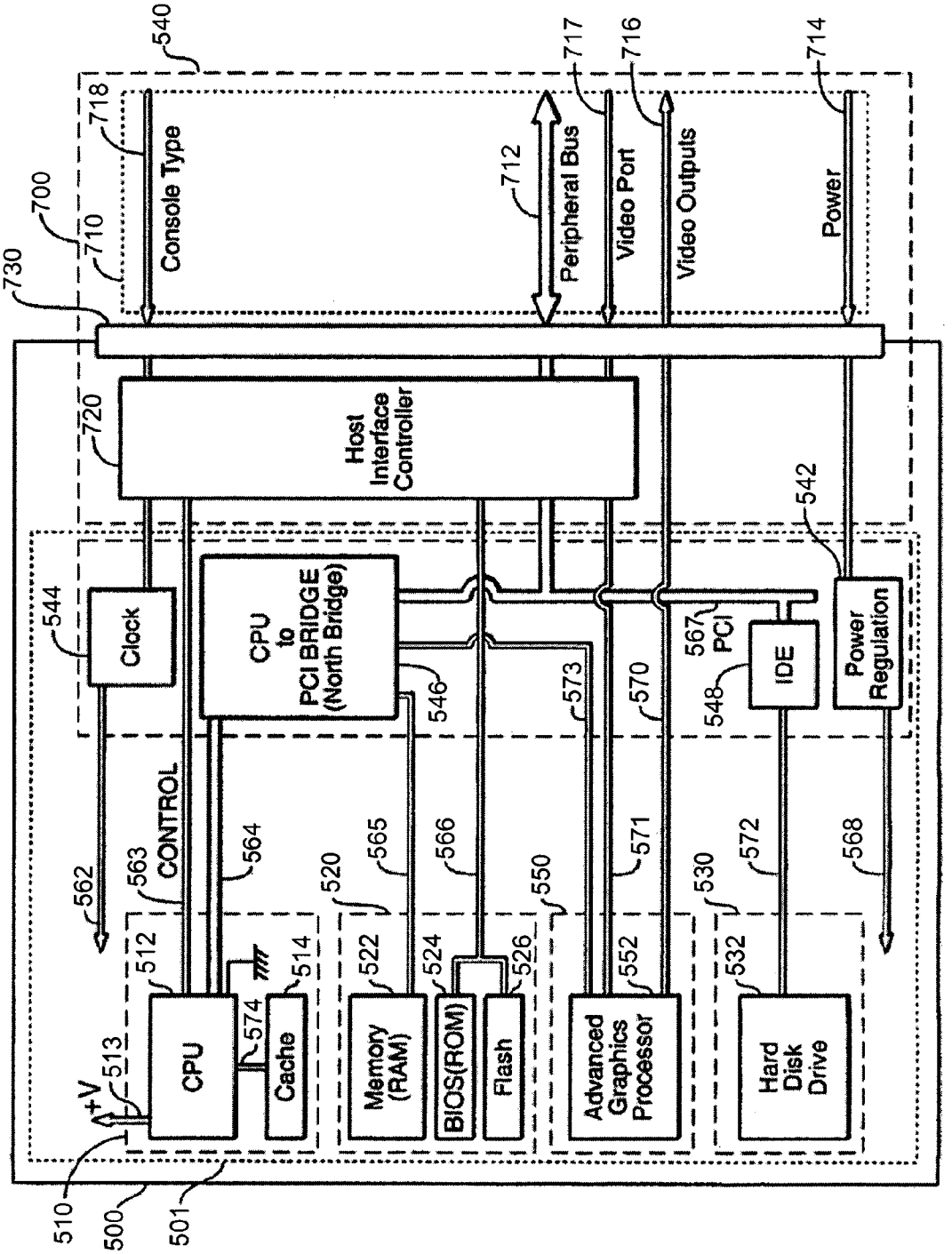
540
718
700
710
730
Console Type
712
Peripheral Bus
717
Video Port
716
Video Outputs
714
Power
720
Host Interface Controller
542
544
Clock
CPU to PCI BRIDGE (North Bridge)
546
573
570
567 PCI
548
IDE
Power Regulation
562
563 CONTROL
564
520
565
566
550
571
530
572
568
512
514
522
524
526
552
532
513
+V
574
CPU
Cache
Memory (RAM)
BIOS(ROM)
Flash
Advanced Graphics Processor
Hard Disk Drive
510
500
501

FIG. 6

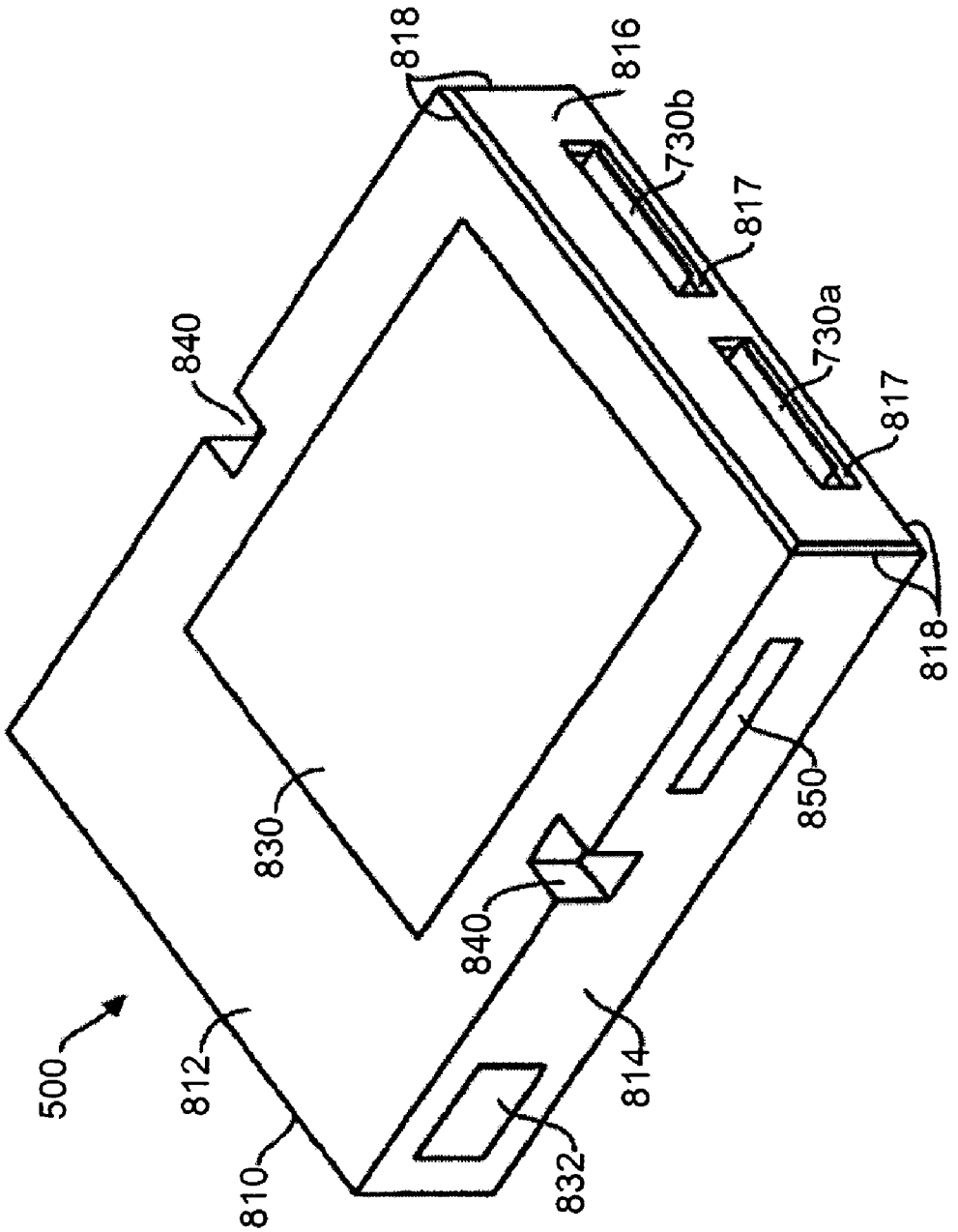
818
816
730b
817
730a
817
840
818
830
850
840
500
812
814
810
832

FIG. 7

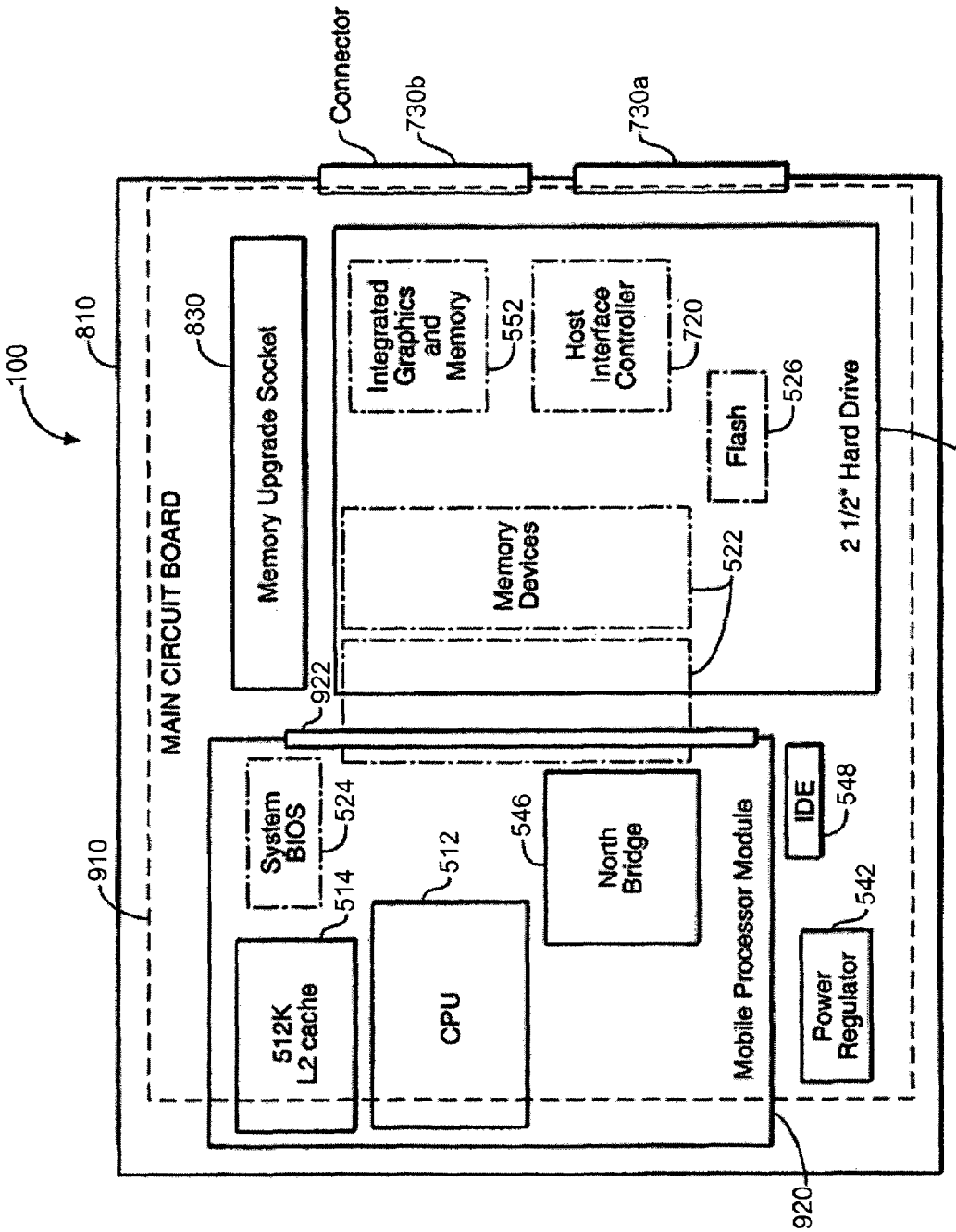
100
810
MAIN CIRCUIT BOARD
830
Memory Upgrade Socket
Connector
730b
730a
Integrated Graphics and Memory
552
Host Interface Controller
720
Flash
526
Memory Devices
522
2 1/2" Hard Drive
532
922
910
System BIOS
524
514
512K L2 cache
512
CPU
546
North Bridge
Mobile Processor Module
IDE
548
Power Regulator
542
920

FIG. 8

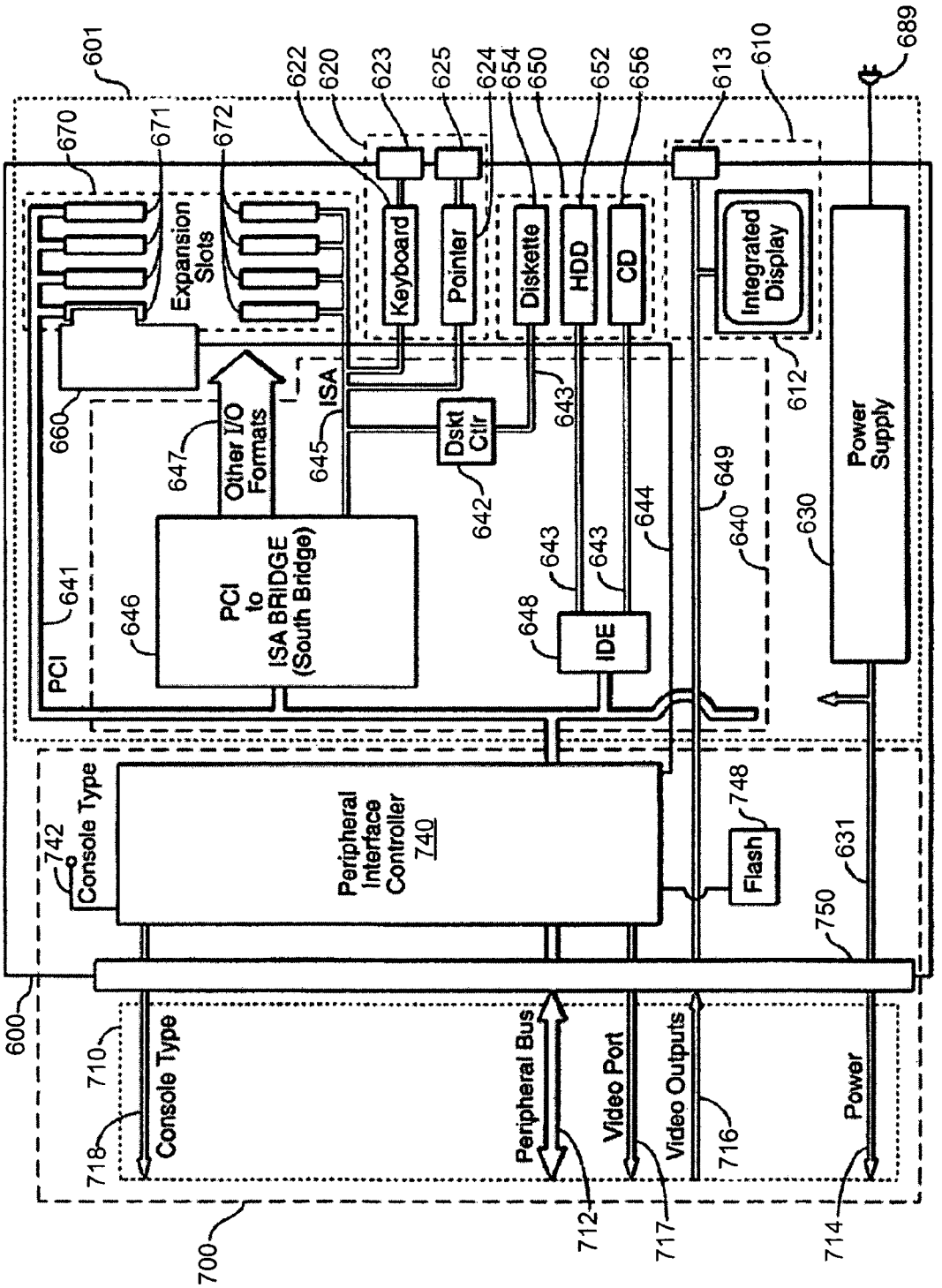
601
622
620
623
625
624
654
650
652
656
613
610
689
670
671
672
Expansion Slots
Keyboard
Pointer
Diskette
HDD
CD
Integrated Display
Power Supply
660
647
Other I/O Formats
645
ISA
Dskt Ctlr
643
612
649
642
644
640
630
PCI
641
646
PCI to ISA BRIDGE (South Bridge)
643
643
648
IDE
Console Type
742
Peripheral Interface Controller 740
748
Flash
631
750
600
710
718
Console Type
Peripheral Bus
Video Port
Video Outputs
716
Power
700
712
717
714

FIG. 9

MULTIPLE MODULE COMPUTER SYSTEM AND METHOD

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims priority as a continuation of U.S. nonprovisional patent application Ser. No. 10/772,214, filed Feb. 3, 2004, which is a continuation of U.S. nonprovisional patent application Ser. No. 09/569,758, filed May 12, 2000 (Now U.S. Pat. No. 6,718,415), which claimed priority to U.S. Provisional Application No. 60/134,122 filed May 14, 1999, commonly assigned, and hereby incorporated by reference.

BACKGROUND OF THE INVENTION

The present invention relates to computing devices. More particularly, the present invention provides a system including a plurality of computer modules that can independently operate to provide backup capability, dual processing, and the like. Merely by way of example, the present invention is applied to a modular computing environment for desk top computers, but it will be recognized that the invention has a much wider range of applicability. It can be applied to a server as well as other portable or modular computing applications.

Many desktop or personal computers, which are commonly termed PCs, have been around and used for over ten years. The PCs often come with state-of-art microprocessors such as the Intel Pentium™ microprocessor chips. They also include a hard or fixed disk drive such as memory in the giga-bit range. Additionally, the PCs often include a random access memory integrated circuit device such as a dynamic random access memory device, which is commonly termed DRAM. The DRAM devices now provide up to millions of memory cells (i.e., mega-bit) on a single slice of silicon. PCs also include a high resolution display such as cathode ray tubes or CRTs. In most cases, the CRTs are at least 15 inches or 17 inches or 20 inches in diameter. High resolution flat panel displays are also used with PCs.

Many external or peripheral devices can be used with the PCs. Among others, these peripheral devices include mass storage devices such as a Zip™ Drive product sold by Iomega Corporation of Utah. Other storage devices include external hard drives, tape drives, and others. Additional devices include communication devices such as a modem, which can be used to link the PC to a wide area network of computers such as the Internet. Furthermore, the PC can include output devices such as a printer and other output means. Moreover, the PC can include special audio output devices such as speakers the like.

PCs also have easy to use keyboards, mouse input devices, and the like. The keyboard is generally configured similar to a typewriter format. The keyboard also has the length and width for easily inputting information by way of keys to the computer. The mouse also has a sufficient size and shape to easily move a curser on the display from one location to another location.

Other types of computing devices include portable computing devices such as "laptop" computers and the like. Although somewhat successful, laptop computers have many limitations. These computing devices have poor display technology. In fact, these devices often have a smaller flat panel display that has poor viewing characteristics. Additionally, these devices also have poor input devices such as smaller keyboards and the like. Furthermore, these devices have limited common platforms to transfer information to and from these devices and other devices such as PCs.

Up to now, there has been little common ground between these platforms including the PCs and laptops in terms of upgrading, ease-of-use, cost, performance, and the like. Many differences between these platforms, probably somewhat intentional, has benefited computer manufacturers at the cost of consumers. A drawback to having two separate computers is that the user must often purchase both the desktop and laptop to have "total" computing power, where the desktop serves as a "regular" computer and the laptop serves as a "portable" computer. Purchasing both computers is often costly and runs "thousands" of dollars. The user also wastes a significant amount of time transferring software and data between the two types of computers. For example, the user must often couple the portable computer to a local area network (i.e., LAN), to a serial port with a modem and then manually transfer over files and data between the desktop and the portable computer. Alternatively, the user often must use floppy disks to "zip" up files and programs that exceed the storage capacity of conventional floppy disks, and transfer the floppy disk data manually.

Another drawback with the current model of separate portable and desktop computer is that the user has to spend money to buy components and peripherals the are duplicated in at least one of these computers. For example, both the desktop and portable computers typically include hard disk drives, floppy drives, CD-ROMs, computer memory, host processors, graphics accelerators, and the like. Because program software and supporting programs generally must be installed upon both hard drives in order for the user to operate programs on the road and in the office, hard disk space is often wasted.

One approach to reduce some of these drawbacks has been the use of a docking station with a portable computer. Here, the user has the portable computer for "on the road" use and a docking station that houses the portable computer for office use.

Similar to separate desktop and portable computers, there is no commonality between two desktop computers. To date, most personal computers are constructed with a single motherboard that provides connection for CPU and other components in the computer. Dual CPU systems have been available through Intel's slot 1 architecture. For example, two Pentium II cartridges can be plugged into two "slot 1" card slots on a motherboard to form a Dual-processor system. The two CPU's share a common host bus that connects to the rest of the system, e.g. main memory, hard disk drive, graphics subsystem, and others. Dual CPU systems have the advantage of increased CPU performance for the whole system. Adding a CPU cartridge requires no change in operating systems and application software. However, dual CPU systems may suffer limited performance improvement if memory or disk drive bandwidth becomes the limiting factor. Also, dual CPU systems have to time-share the processing unit in running multiple applications. CPU performance improvement efficiency also depends on software coding structure. Dual CPU systems provide no hardware redundancy to help fault tolerance. In running multiple applications, memory and disk drive data throughput will become the limiting factor in improving performance with multi-processor systems.

Thus, what is needed are computer systems that can have multiple computer modules. Each computer module has dedicated memory and disk drive, and can operate independently.

BRIEF SUMMARY OF THE INVENTION

According to the present invention, a technique including a method and device for multi-module computing is provided. In an exemplary embodiment, the present invention provides a system including a plurality of computer modules that can independently operate to provide backup capability, dual processing, and the like.

In a specific embodiment, the present invention provides a computer system for multi-processing purposes. The computer system has a console comprising a first coupling site and a second coupling site, e.g., computer module bay. Each coupling site comprises a connector. The console is an enclosure that is capable of housing each coupling site. The system also has a plurality of computer modules, where each of the computer modules is coupled to one of the connectors. Each of the computer modules has a processing unit, a main memory coupled to the processing unit, a graphics controller coupled to the processing unit, and a mass storage device coupled to the processing unit. Each of the computer modules is substantially similar in design to each other to provide independent processing of each of the computer modules in the computer system.

In an alternative specific embodiment, the present invention provides a multi-processing computer system. The system has a console comprising a first coupling site and a second coupling site. Each coupling site comprises a connector. The console is an enclosure that is capable of housing each coupling site. The system also has a plurality of computer modules, where each of the computer modules is coupled to one of the connectors. Each of the computer modules has a processing unit, a main memory coupled to the processing unit, a graphics controller coupled to the processing unit, a mass storage device coupled to the processing unit, and a video output coupled to the processing unit. Each of the computer modules is substantially similar in design to each other to provide independent processing of each of the computer modules in the computer system. A video switch circuit is coupled to each of the computer modules through the video output. The video switch is configured to switch a video signal from any one of the computer modules to a display.

Numerous benefits are achieved using the present invention over previously existing techniques. In one embodiment, the invention provides improved processing and maintenance features. The invention can also provide increased CPU performance for the whole system. The invention also can be implemented without changes in operating system and application software. The present invention is also implemented using conventional technologies that can be provided in the present computer system in an easy and efficient manner.

In another embodiment, the invention provides at least two users to share the same modular desktop system. Each user operates on a different computer module. The other peripheral devices, i.e. CDROM, printer, DSL connection, etc. can be shared. This provides lower system cost, less desktop space and more efficiency. Depending upon the embodiment, one or more of these benefits can be available. These and other advantages or benefits are described throughout the present specification and are described more particularly below.

In still further embodiments, the present invention provides methods of using multiple computer modules.

These and other embodiments of the present invention, as well as its advantages and features, are described in more detail in conjunction with the text below and attached Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified diagram of a computer system according to an embodiment of the present invention;

FIG. **2** is a simplified block diagram of a computer system according to an alternative embodiment of the present invention;

FIG. **3** is a simplified block diagram of a computer system according to a further alternative embodiment of the present invention; and

FIG. **4** is a simplified flow diagram of a method according to an embodiment of the present invention.

FIG. **5** is a block diagram of one embodiment of a computer system employing the present invention.

FIG. **6** is a block diagram of an attached computing module (ACM).

FIG. **7** illustrates an external view of one embodiment of an ACM.

FIG. **8** illustrates the internal component layout for one embodiment of an ACM.

FIG. **9** is a block diagram of a peripheral console (PCON).

DETAILED DESCRIPTION OF THE INVENTION

According to the present invention, a technique including a method and device for multi-module computing is provided. In an exemplary embodiment, the present invention provides a system including a plurality of computer modules that can independently operate to provide backup capability, dual processing, and the like.

FIG. **1** is a simplified diagram of a computer system **100** according to an embodiment of the present invention. This diagram is merely an illustration and should not limit the scope of the claims herein. One of ordinary skill in the art would recognize other variations, modifications, and alternatives. The computer system **100** includes an attached computer module (i.e., ACM) **113**, a desktop console **101**, among other elements. The computer system also has another ACM module **117**. Each ACM module has a respective slot **121**, **119**, which mechanically houses and electrically couples each ACM to the computer console. Also shown is a display **111**, which connects to the console. Additionally, keyboard **109** and mouse **115** are also shown. A second display **102**, keyboard **105**, and mouse **107** can be coupled to the console in some optional embodiments to allow more than one user to operate the computer system. The computer system is modular and has a variety of components that are removable. Some of these components (or modules) can be used in different computers, workstations, computerized television sets, and portable or laptop units.

In the present embodiment, each ACM **113** includes computer components, as will be described below, including a central processing unit ("CPU"), IDE controller, hard disk drive, computer memory, and the like. The computer module bay (i.e., CMB) **121** is an opening or slot in the desktop console. The CMB houses the ACM and provides communication to and from the ACM. The CMB also provides mechanical protection and support to the ACM. The CMB has a mechanical alignment mechanism for mating a portion of the ACM to the console. The CMB further has thermal

heat dissipation sinks, electrical connection mechanisms, and the like. Some details of the ACM can be found in co-pending patent application Ser. Nos. 09/149,882 and 09/149,548 filed Sep. 8, 1998, commonly assigned, and hereby incorporated by reference for all purposes.

In a specific embodiment, the present multiple computer module system has a peripheral console that has two or more computer bays that can receive a removable computer module or ACM. Multiple computer module system can function as a personal computer with only one ACM and the peripheral console. The second and additional ACM can be added later to increase overall system performance and reliability. The ACM operates independently as self-contained computer, communicates with each other through a high-speed serial communication and share most peripheral devices within the peripheral console. Each ACM controls its independent graphics subsystem and drives separate video output signals. A practical implementation is a dual ACM system. In a dual ACM system, two monitors can be used to display the two ACMs' graphics outputs at the same time. For a single monitor, a RGB switch is used to switch between the video outputs of the two ACMs and can be controlled by a command from the user. Similarly, input devices (i.e. keyboard and mouse) are switched between the two computer systems with a command from the user. Command from the user can be in the form of either a dedicated key on the keyboard or a special icon on the screen that the mouse can click on.

In most embodiments, the ACM includes an enclosure such as the one described with the following components, which should not be limiting:

1) A CPU with cache memory;
2) Core logic device or means;
3) Main memory;
4) A single primary Hard Disk Drive ("HDD") that has a security program;
5) Flash memory with system BIOS and programmable user password;
6) Operating System, application software, data files on primary HDD;
7) An interface device and connectors to peripheral console;
8) A software controllable mechanical lock, lock control means, and other accessories.

The ACM connects to a peripheral console with power supply, a display device, an input device, and other elements. Some details of these elements with the present system are described in more detail below. In a dual ACM system, the primary ACM can connect directly to the peripheral board in the peripheral console. The second ACM can connect either directly or indirectly to the peripheral board. For indirect connection, a receptacle board is added to allow a cable connection to the peripheral board. This is to facilitate the mechanical positioning of the second ACM inside the computer chassis. The receptacle board approach can even be used for the primary ACM if a high bandwidth peripheral bus, e.g. PCI Bus, is not connected from the primary ACM to the peripheral board.

The shared peripheral console has a chassis and a motherboard that connects the following devices:

1) Input means, e.g. keyboard and mouse,
2) Display means, e.g. RGB monitor,
3) Add-on means, e.g. PCI add-on slots,
4) Two Computer Module Bays (CMB) with connectors to two ACMs,
5) A serial communication Hub controller that interfaces to serial communication controller of both ACMs,
6) Shared storage subsystem, e.g. Floppy drive, CDROM drive, DVD drive, or 2nd Hard Drive,
7) Communication device, e.g. modem,
8) Power supply, and others.

The computer bay is an opening in the peripheral console that receives an ACM. CMB provides mechanical protection to ACM, mechanical alignment for connector mating, mechanical locking system to prevent theft and accidental removal, and connectors at the end of the opening for connecting to ACM. The interface bus between ACM and the peripheral console has a video bus, peripheral connections, serial communication connection, control signals and power connection. Video bus includes video output of graphics devices, i.e. analog RGB and control signals for monitor. Power connection supplies the power for ACM.

An implementation of peripheral sharing is the use of Ethernet controllers to bridge the communication between the two ACMs. Some of the peripheral devices residing in the peripheral console are shown in the simplified diagram of FIG. **2**. As shown, the diagram is merely an illustration which should not limit the scope of the claims herein. One of ordinary skill in the art would recognize many other variations, alternatives, and modifications. As shown, a primary ACM **203** is connected to PCI peripheral devices in the peripheral console through the PCI bus **225** that passes through the connection between primary ACM **203** and peripheral console **201**. As shown, ACM has a CPU module **207** coupled to the PCI bus through a North Bridge **211**.

The CPU module can use a suitable microprocessing unit, microcontroller, digital signal processor, and the like. In a specific embodiment, the CPU module uses, for example, a 400 MHz Pentium II microprocessor module from Intel Corporation and like microprocessors from AMD Corporation, Cyrix Corporation (now National Semiconductor Corporation), and others. In other aspects, the microprocessor can be one such as the Compaq Computer Corporation Alpha Chip, Apple Computer Corporation PowerPC G3 processor, and the like. Further, higher speed processors are contemplated in other embodiments as technology increases in the future.

In the CPU module, peripheral controller **213** is coupled to BIOS/flash memory **217**. Additionally, the peripheral controller is coupled to a clock control logic, a configuration signal, and a peripheral bus. The ACM has the hard drive module **215**. Among other elements, the ACM includes north bridge **215**, graphics subsystem **223** (e.g., graphics accelerator, graphics memory), an IDE controller, and other components. Adjacent to and in parallel alignment with the hard drive module **215** is the PCI bus. In a specific embodiment, North Bridge unit **211** often couples to a computer memory **209**, to the graphics subsystem, and to the peripheral controller via the PCI bus. Graphics subsystem typically couples to a graphics memory, and other elements. IDE controller generally supports and provides timing signals necessary for the IDE bus. In the present embodiment, the IDE controller is embodied as part of a P114XE controller from Intel, for example. Other types of buses than IDE are contemplated, for example EIDE, SCSI, 1394, and the like in alternative embodiments of the present invention.

The hard drive module or mass storage unit **215** typically includes a computer operating system, application software program files, data files, and the like. In a specific embodiment, the computer operating system may be the Windows98 operating system from Microsoft Corporation of Redmond Wash. Other operating systems, such as WindowsNT, MacOS8, Unix, and the like are also contemplated in alternative embodiments of the present invention. Further,

some typical application software programs can include Office98 by Microsoft Corporation, Corel Perfect Suite by Corel, and others. Hard disk module **215** includes a hard disk drive. The hard disk drive, however, can also be replaced by removable hard disk drives, read/write CD ROMs, flash memory, floppy disk drives, and the like. A small form factor, for example 2.5", is currently contemplated, however, other form factors, such as PC card, and the like are also contemplated. Mass storage unit **240** may also support other interfaces than IDE.

Among other features, the computer system includes an ACM with security protection.

The ACM also has a network controller, which can be an Ethernet controller **219**, which is coupled to the North Bridge through the PCI bus. The North Bridge is coupled to the CPU. The Ethernet controller can be a 10/100 Base, such as Intel's 82559 or the like. Other types of network connection devices can also be used. For example, the invention can use Gbit Ethernet 1394, and USB 2.0. The network controller couples to a hub **233** in the console, which includes shared peripheral system **201**.

Also shown is the second ACM **205**. The second ACM has the same or similar components as the first ACM. Here, like reference numerals have been used for easy cross-referencing, but is not intended to be limiting. In some embodiments, the secondary ACM is not connected to the PCI bus in the peripheral console directly. The secondary ACM **219** accesses peripheral devices controlled by the primary ACM through the Ethernet connection to the primary ACM, e.g. CD-ROM, or PCI modem. The implementation is not restricted to Ethernet serial communication and can use other high-speed serial communication such as USB 2.0, and 1394. The Ethernet hub is coupled to an external output port **235**, which connects to an external network.

The primary hard disk drive in each ACM can be accessed by the other ACM as sharable hard drive through the Ethernet connection. This allows the easy sharing of files between the two independent computer modules. The Ethernet Hub Controller provides the high-speed communication function between the two computer modules. Ethernet data bandwidth of 100 Mbit/sec allows fast data communication between the two computer modules. The secondary ACM access peripheral devices of the primary ACM through the network connection provided by Ethernet link. The operating system, e.g. Windows 98, provides the sharing of resources between the two ACMs. In some embodiments, critical data in one ACM can be backup into the other ACM.

The Ethernet hub also couples to PCI bus **239**, which connects to PCI devices **241**, **243**, e.g., modem, SCSI controller. A flash memory **242** can also be coupled to the PCI bus. The flash memory can store passwords and security information, such as those implementations described in U.S. Ser. No. 09/183,493, which is commonly owned, and hereby incorporated by reference. The hub **233** also couples to an I/O control **237**, which connects to keyboard/mouse switch **245**, which couples to keyboard/mouse **247**. Optionally, the keyboard/mouse switch also couples to a second keyboard/house **259** via PS2 or USB signal line **251**. The keyboard/mouse switch has at least a first state and a second state, which allow operation of respectively multiple keyboards or a single keyboard. The switch also couples to each I/O controller **221** in each ACM via lines **253**, **255**. The I/O control **237** also couples to an RGB switch **257**, which allows video signals to pass to the first monitor **259**. Alternatively, the RGB switch couples to a second monitor **261**. The RGB switch includes analog video switches such as MAXIM's MAX4545.

The peripheral system **201** also has an independent power supply **231** for each ACM. Each power supply provides power to each ACM. As merely an example, the power supply is a MICRO ATX 150W made by ENLIGHT, but can be others. The power supply is connected or coupled to each ACM through a separate line, for example. The independent power supply allows for independent operation of each ACM in some embodiments.

The above embodiments are described generally in terms of hardware and software. It will be recognized, however, that the functionality of the hardware can be further combined or even separated. The functionality of the software can also be further combined or even separated. Hardware can be replaced, at times, with software. Software can be replaced, at times, with hardware. Accordingly, the present embodiments should not be construed as limiting the scope of the claims here. One of ordinary skill in the art would recognize other variations, modifications, and alternatives.

FIG. **3** is a simplified block diagram **300** of a computer system according to an alternative embodiment of the present invention. This diagram is merely an example which should not limit the scope of the claims herein. One of ordinary skill in the art would recognizes many other variations, modifications, and alternatives. Like reference numerals are used in this FIG. as the previous FIGs. for easy referencing, but are not intended to be limiting. As shown, each ACM includes common elements as the previous FIG. A primary ACM **203** is connected to PCI peripheral devices in the peripheral console through the PCI bus **225** that passes through the connection between primary ACM **203** and peripheral console **201**. As shown, ACM has a CPU module **207** coupled to the PCI bus through a North Bridge **211**.

The CPU module can use a suitable microprocessing unit, microcontroller, digital signal processor, and the like. In a specific embodiment, the CPU module uses, for example, a 400 MHz Pentium II microprocessor module from Intel Corporation and like microprocessors from AMD Corporation, Cyrix Corporation (now National Semiconductor Corporation), and others. In other aspects, the microprocessor can be one such as the Compaq Computer Corporation Alpha Chip, Apple Computer Corporation PowerPC G3 processor, and the like. Further, higher speed processors are contemplated in other embodiments as technology increases in the future.

In the CPU module, peripheral controller **213** is coupled to BIOS/flash memory **217**. Additionally, the peripheral controller is coupled to a clock control logic, a configuration signal, and a peripheral bus. The ACM has the hard drive module **215**. Among other elements, the ACM includes north bridge **215**, graphics subsystem **223** (e.g., graphics accelerator, graphics memory), an IDE controller, and other components. Adjacent to and in parallel alignment with the hard drive module **215** is the PCI bus. In a specific embodiment, North Bridge unit **211** often couples to a computer memory **209**, to the graphics subsystem, and to the peripheral controller via the PCI bus. Graphics subsystem typically couples to a graphics memory, and other elements. IDE controller generally supports and provides timing signals necessary for the IDE bus. In the present embodiment, the IDE controller is embodied as part of a P114XE controller from Intel, for example. Other types of buses than IDE are contemplated, for example EIDE, SCSI, 1394, and the like in alternative embodiments of the present invention.

The hard drive module or mass storage unit **215** typically includes a computer operating system, application software program files, data files, and the like. In a specific embodiment, the computer operating system may be the Windows98 operating system from Microsoft Corporation of Redmond Wash. Other operating systems, such as WindowsNT, MacOS8, Unix, and the like are also contemplated in alternative embodiments of the present invention. Further, some typical application software programs can include Office98 by Microsoft Corporation, Corel Perfect Suite by Corel, and others. Hard disk module **215** includes a hard disk drive. The hard disk drive, however, can also be replaced by removable hard disk drives, read/write CD ROMs, flash memory, floppy disk drives, and the like. A small form factor, for example 2.5", is currently contemplated, however, other form factors, such as PC card, and the like are also contemplated. Mass storage unit **240** may also support other interfaces than IDE.

Among other features, the computer system includes an ACM with security protection.

The ACM also has a network controller, which can be coupled to a serial port **302**, which is coupled to the PCI bus in the ACM. The serial port is coupled to the peripheral console through a serial controller **301** in the serial console. The serial controller is connected to PCI bus **239**. The serial controller is also coupled to a serial hub controller **303**, which is coupled to the PCI bus and a second ACM. In a specific embodiment, a receptacle board **310** is added to connect to the second ACM. The purpose of the receptacle board is to allow a cable connection **307** to the peripheral board **300**. The cable connection is possible because the signals needed to connect to the peripheral board can be limited to video, I/O, serial communication, and power. The serial communication controller can be placed on the receptacle board and not in the ACM. As shown, the serial bus controller couples to the PCI bus. The receptacle board also couples to power, graphics subsystem, I/O controller, and other elements, which may be on a common bus. The overall operation of the present configuration is similar to the previous one except it operates in serial communication mode.

The Dual ACM system can support different usage models:

1. One user using both ACMs concurrently with 1 or 2 monitors, and a common keyboard/mouse.

2. Two users using the two separate ACMs at the same time with separate monitors and keyboard/mouse. The 2 users share peripherals, e.g., printer, CDROM, and others. The two users share external networking.

To support 1 monitor for both ACMs, a video switch in the peripheral console is used to switch between the video outputs of the two ACMs. The system can be set to support either 1 monitor or 2-monitor mode. The user presses a special key on the keyboard or a special icon on the screen to switch the screen display from one ACM to the other. This same action causes the keyboard and mouse connections to switch from one ACM to the other ACM.

A dual ACM system can save space, wiring, and cost for a 2-person PC setup, with the added benefit that both PC systems can be accessed from one user site for increased system performance if the other user is not using the system. Files can be copied between the primary drive of both system and provides protection against a single ACM failure. Software needs to be developed to manage the concurrent use of two PC subsystems, the automatic sharing of selected files between the two systems, and fault tolerance.

The design with more than two computer modules can be implemented with the use of multi-port, serial communication hub controller and multi-port I/O switches. In one embodiment, a peripheral console has four computer bays for four separate computer modules. The computer modules communicate through a four port Ethernet hub. The video, keyboard, and mouse switch will cycle through the connection from each computer module to the external monitor, keyboard, and mouse with a push button sequentially. This embodiment is useful for a server that performs different functions concurrently, e.g. email, application hosting, web hosting, firewall, etc.

The above embodiments are described generally in terms of hardware and software. It will be recognized, however, that the functionality of the hardware can be further combined or even separated. The functionality of the software can also be further combined or even separated. Hardware can be replaced, at times, with software. Software can be replaced, at times, with hardware. Accordingly, the present embodiments should not be construed as limiting the scope of the claims here. One of ordinary skill in the art would recognize other variations, modifications, and alternatives.

FIG. **4** is a simplified diagram of a method according to an embodiment of the present invention. This diagram is merely an example which should not limit the scope of the claims herein. One of ordinary skill in the art would recognize many other variations, modifications, and alternatives. The present diagram illustrates an automatic file backup procedure from one computer module to the other. As shown, a user selects (step **401**) a certain file in one of the computer module for automatic backup. Next, the method determines if another module is available, step **403**. If so, the method in the originating module requests the other computer module to create (step **405**) backup file. Alternatively, the method alerts the user of the missing or malfunctioning module, step **429**. The method then has the user try later **431**, once the missing or malfunctioning module has been replaced or repaired. Next, the method determines if there is sufficient storage available in the other computer module for the backup files. If so, the method goes to the next step. (Alternatively, the method prompts (step **433**) a message to the user indicating that the storage is full.) In the next step, the method stores the backup file in memory of the other module. After the backup file has been successfully created (step **409**), the software in the originating ACM sets a timer to check (step **411**) for file modification via branches **423**, **427** through continue, step **425** process. If a file selected for backup has been modified (step **415**), then the file is automatically back up to the other ACM again, step **417**. Alternatively, the method returns to step **411** through branch **421**.

The above embodiments are described generally in terms of hardware and software. It will be recognized, however, that the functionality of the hardware can be further combined or even separated. The functionality of the software can also be further combined or even separated. Hardware can be replaced, at times, with software. Software can be replaced, at times, with hardware. Accordingly, the present embodiments should not be construed as limiting the scope of the claims here. One of ordinary skill in the art would recognize other variations, modifications, and alternatives.

FIG. **5** is a block diagram of the components in one computer system employing the present invention. The computer system comprises an attached computer module (ACM), a peripheral console (PCON), and the interconnection apparatus between them. The ACM includes the central processing unit (CPU) **510**, system memory **520**, high

performance devices **550**, primary mass storage **530**, and related interface and support circuitry **540**. The PCON includes primary display **610**, primary input **620**, secondary mass storage **650**, other devices **660**, expansion slots **670**, the primary power supply **630**, and related interface and support circuitry **640**. The interconnection apparatus **700** includes circuitry to convey power and operational signals between the ACM and PCON.

Within the ACM **500**, the CPU **510** executes instructions and manipulates data stored in the system memory. The CPU **510** and system memory **520** represent the user's core computing power. The core computing power may also include high performance devices **550** such as advanced graphics processor chips that greatly increase overall system performance and which, because of their speed, need to be located close to the CPU. The primary mass storage **530** contains persistent copies of the operating system software, application software, configuration data, and user data. The software and data stored in the primary mass storage device represent the user's computing environment. Interface and support circuitry **540** primarily includes interface chips and signal busses that interconnect the CPU, system memory, high performance devices, and primary mass storage. The interface and support circuitry also connects ACM-resident components with the ACM-to-PCON interconnection apparatus as needed.

Within the PCON **600**, the primary display component **610** may include an integrated display device or connection circuitry for an external display device. This primary display device may be, for example, an LCD, plasma, or CRT display screen used to display text and graphics to the user for interaction with the operating system and application software. The primary display component is the primary output of the computer system, i.e., the paramount vehicle by which programs executing on the CPU can communicate toward the user.

The primary input component **620** of the PCON may include an integrated input device or connection circuitry for attachment to an external input device. The primary input may be, for example, a keyboard, touch screen, keypad, mouse, trackball, digitizing pad, or some combination thereof to enable the user to interact with the operating system and application software. The primary input component is the paramount vehicle by which programs executing on the CPU receive signals from the user.

The PCON may contain secondary mass storage **650** to provide additional high capacity storage for data and software. Secondary mass storage may have fixed or removable media and may include, for example, devices such as diskette drives, hard disks, CD-ROM drives, DVD drives, and tape drives.

The PCON may be enhanced with additional capability through the use of integrated "Other Devices" **660** or add-on cards inserted into the PCON's expansion slots **670**. Examples of additional capability include sound generators, LAN connections, and modems. Interface and support circuitry **640** primarily includes interface chips, driver chips, and signal busses that interconnect the other components within the PCON. The interface and support circuitry also connects PCON-resident components with the ACM-to-PCON interconnection apparatus as needed.

Importantly, the PCON houses the primary power supply **630**. The primary power supply has sufficient capacity to power both the PCON and the ACM **500** for normal operation. Note that the ACM may include a secondary "power supply" in the form, for example, of a small battery. Such a power supply would be included in the ACM to maintain, for example, a time-of-day clock, configuration settings when the ACM is not attached to a PCON, or machine state when moving an active ACM immediately from one PCON to another. The total energy stored in such a battery would, however, be insufficient to sustain operation of the CPU at its rated speed, along with the memory and primary mass storage, for more than a fraction of an hour, if the battery were able to deliver the required level of electrical current at all.

FIG. **6** is a block diagram of an attached computing module (ACM) **500**. The physical ACM package **500** contains the ACM functional components **501** and the ACM side of the ACM-to-PCON Interconnection **300**. The ACM **501** comprises a CPU component **510**, a system memory component **520**, a primary mass storage component **530**, a high performance devices components **550**, and an interface and support component **540**.

The ACM side of the ACM-to-PCON Interconnection **700** comprises a Host Interface Controller (HIC) component **720** and an ACM connector component **730**. The HIC **720** and connector **730** components couple the ACM functional components **800** with the signals of an ACM-to-PCON interface bus **710** used to operatively connect an ACM with a PCON. The ACM-to-PCON interface bus **710** comprises conveyance for electrical power **714** and signals for a peripheral bus **712**, video **716**, video port **717**, and console type **718**. The preferred ACM-to-PCON Interconnection **700** is described in detail in a companion U.S. patent application Ser. No. 09/149,882, entitled "A Communication Channel and Interface Devices for Bridging Computer Interface Buses," by the same inventor, filed on the same day herewith, and hereby incorporated by reference. The preferred ACM-to-PCON interconnection **700** includes circuitry to transmit and receive parallel bus information from multiple signal paths as a serial bit stream on a single signal path. This reduces the number of physical signal paths required to traverse the interconnection **700**. Further, employing low-voltage differential signaling (LVDS) on the bit stream data paths provides very reliable, high-speed transmission across cables. This represents a further advantage of the present invention.

The CPU component **510** of the ACM functional circuitry **501** of the presently described embodiment comprises a microprocessor **512**, which is the chief component of the personal computer system, power supply connection point **513**, and cache memory **514** tightly coupled to the microprocessor **512** by the CPU-to-cache bus **574** comprising signal paths for address, data, and control information. The microprocessor **512** of this embodiment is one of the models from the Pentium II family of processors from Intel Corporation. Microprocessor **512** receives electrical power from power bus **568** via connection point **513**. Microprocessor **512** couples to the Host Interface Controller (HIC) **720** via CPU-to-HIC bus **563** comprising signal paths to exchange control information such as an interrupt request. Microprocessor **512** also couples to CPU Bridge **546** via CPU main bus **564** comprising signal paths for address, data, and control information.

The CPU Bridge component **546** of the interface and support circuitry **540** operates to couple the high speed CPU main bus **564** to specialty buses of varying speeds and capability that connect other computer components. The CPU Bridge of the presently described embodiment incorporates memory controller circuitry, advanced graphics processor support circuitry, and a general, industry-standard

PCI bus controller in a single package. A CPU Bridge **546** such as the 52443LX PCI/AGP Controller from Intel Corporation may be used.

The system memory component **520** of the ACM functional circuitry **501** in the present embodiment comprises main system memory (RAM) **522**, BIOS memory **524**, and flash memory **526**. The system memory **520** is used to contain data and instructions that are directly addressable by the CPU. The RAM **522** comprises volatile memory devices such as DRAM or SDRAM memory chips that do not retain their stored contents when power is removed. This form of memory represents the largest proportion of total system memory **520** capacity. The BIOS memory **524** comprises non-volatile memory devices such as ROM or EPROM memory chips that retain their stored contents regardless of the application of power and are read-only memory under normal operating conditions. The BIOS memory **524** stores, for example, start-up instructions for the microprocessor **512** and sets of instructions for rudimentary input/output tasks. The flash memory **526** comprises non-volatile memory devices that retain their stored contents regardless of the application of power. Unlike the BIOS non-volatile memory, however, the stored contents of the flash memory **526** are easily changed under normal operating conditions. The flash memory **526** may be used to store status and configuration data, such as security identifiers or ACM specifications like the speed of the microprocessor **512**. Some embodiments may combine the BIOS functions into the flash memory device, thus permitting BIOS contents to be rewritten, improving field upgradability.

The main system memory (RAM) **522** is coupled to memory controller circuitry resident within the CPU Bridge **546** via direct memory bus **565**. The BIOS **524** and flash memory **526** are coupled to HIC **720** via switched memory bus **566**. This permits the BIOS **524** and flash **526** memories to be accessed by circuitry in the HIC **720** or other circuitry connected thereto. The direct memory bus **565** and the switch memory bus **566** each comprises conductors to convey signals for data, address, and control information.

The primary mass storage component **530** of the ACM functional circuitry **501** in the present embodiment comprises a compact hard disk drive with an industry-standard, IDE interface. The hard disk drive (HDD) **532** has a formatted storage capacity sufficient to contain an operating system for the computer, application software desired by the user, and related user configuration and operating parameter data. The HDD **532** in the present embodiment serves as the "boot" device for the personal computer from which the operating system is loaded into RAM **522** by the start-up program stored in the BIOS **524**.

The present HDD **532** has a capacity of approximately 6,000 megabytes to provide adequate storage for common software configurations and reasonable space for user data. One example of a common software configuration includes the Windows 95 operating system from Microsoft Corporation, a word processing program, a spreadsheet program, a presentation graphics program, a database program, an email program, and a web browser such as Navigator from Netscape Corporation. The hard disk **532** stores program and data files for each software component, including files distributed by the vendor as well as files created or updated by operation of the software after it is installed. For example, a word processor program may maintain information about a user's identity and latest preferences in an operating system registry file. Or, for example, the web browser may maintain a file of the user's favorite web sites or most recently viewed web pages. An HDD with 6000 megabyte capacity is readily available in the small size of hard disk (e.g., 6.5-inch or 7.5-inch) to minimize the space required within the ACM for the primary mass storage device **530**.

The HDD **532** is coupled to IDE controller circuitry **548** via IDE bus **572**. The IDE controller circuitry **548** is coupled to the CPU Bridge **546** via the Host PCI bus **567**. IDE controllers and busses, and the PCI bus are well known and understood in the industry. The above components operate together to couple the hard disk drive **532** to the microprocessor **512**.

The high performance devices component **550** of the ACM functional circuitry **501** in the present embodiment comprises an Advanced Graphics Processor (AGP) **552**. The Model 740 Graphics Device from Intel Corporation may be used in the present embodiment as the AGP.

Increases in computer screen size, graphics resolution, color depth, and visual motion frame rates, used by operating system and application software alike, have increased the computing power required to generate and maintain computer screen displays. An AGP removes a substantial portion of the graphics computing burden from the CPU to the specialized high-performance processor, but a high level of interaction between the CPU and the specialized processor is nonetheless required. To maximize the effective contribution of having a specialized processor in the presently described embodiment, the AGP **552** is located in the ACM **500**, where it is in close proximity to the microprocessor **512**. The AGP **552** is coupled to the microprocessor **512** via the advanced graphics port bus **573** of the CPU Bridge **546**. The visual display signal generated by the AGP are conveyed toward actual display devices at the peripheral console (PCON) via video signal bus **570**. Video information from a source external to the ACM and appearing as video port signals **717** may be conveyed to the AGP **552** via video port signal path **571**.

Other types of high performance components may be included in different ACM configurations. For example, an interface to an extremely high speed data communication facility may be desirable in some future computer where CPU-to-network interaction is of comparable intensity to today's CPU-to-graphics interaction. Because such high performance components tend to be high in cost, their inclusion in the ACM is desirable. Inclusion of high cost, high performance components in the ACM concentrates a user's core computing power and environment in a portable package. This represents a further advantage of the invention.

The interface and support component **540** of the ACM functional circuitry **501** in the present embodiment comprises circuitry for power regulation **542**, clocking **544**, CPU Bridge **546**, IDE controller **548**, and signal conveyance paths **561–174**. The CPU Bridge **546** couples the CPU component **510** of the ACM **500** with the other components of the ACM **520–150** and the CPU-to-PCON Interconnection **700**. The CPU Bridge **546** and IDE controller **548** have already been discussed. Power regulation circuitry **542** receives electrical power via the electrical power conduction path **714** of the CPU-to-PCON Interconnection **700**, conditions and distributes it to the other circuitry in the ACM using power distribution bus **568**. Such regulation and distribution is well known and understood in the art.

Clocking circuitry **544** generates clock signals for distribution to other components within the ACM **500** that require a timing and synchronization clock source. The CPU **510** is one such component. Often, the total power dissipated by a CPU is directly proportional to the frequency of its main clock signal. The presently described embodiment of the

ACM **500** includes circuitry that can vary the frequency of the main CPU clock signal conveyed to the CPU via signal path **562**, in response to a signal received from the host interface controller (HIC) **720** via signal path **561**. The generation and variable frequency control of clocking signals is well understood in the art. By varying the frequency, the power consumption of the CPU (and thus the entire ACM) can be varied.

The variable clock rate generation may be exploited to match the CPU power consumption to the available electrical power. Circuitry in the host interface controller (HIC) **720** of the presently described embodiment adjusts the frequency control signal sent via signal path **561** to the clocking circuitry **544**, based on the "console type" information signal **718** conveyed from the peripheral console (PCON) by the CPU-to-PCON interconnection **700**. In this arrangement, the console type signal originating from a desktop PCON would result in the generation of a maximum speed CPU clock. The desktop PCON, presumably has unlimited power from an electrical wall outlet and does not need to sacrifice speed for power conservation. The console type signal originating from a notebook PCON would, however, result in the generation of a CPU clock speed reduced from the maximum in order to conserve battery power and extend the duration of computer operation obtained from the energy stored in the battery. The console type signal originating from a notepad PCON would result in the generation of a CPU clock speed reduced further yet, the notepad PCON presumably having smaller batteries than the notebook PCON. Inclusion of control signals and circuitry to effect a CPU clock signal varying in frequency according to characteristics of the PCON to which the ACM is connected facilitates the movement of the user's core computing power and environment to different work settings, which is a further advantage of the present invention.

FIG. **9** illustrates an external view of one embodiment of an ACM. The case **810** of the ACM **500** is generally rectangular in shape, preferably constructed of a strong, lightweight, rigid material that will protect the internal components from mechanical and environmental exposure. Plastics may readily be used to construct the case **810**. The case **810** completely surrounds the internal components, being generally an 8-sided box. FIG. **8** shows the top **812**, right **814**, and rear **816** surfaces of the ACM case **810**. Rear edges **818** of the case joining the rear surface **816** with its adjoining surfaces may be beveled or rounded to facilitate insertion of the ACM **500** into the computer bay of the PCON. Notches **840** may be formed by projecting small surfaces inward from otherwise generally flat surfaces of the ACM case **810**. The notches **840** may be used to engage with mechanical devices mounted in and about a computer bay. Such mechanical devices can be employed to secure the ACM into position within a computer bay for reliability and security. Openings **817** are formed into the rear surface **816** of the ACM case **810** through which to project connectors **530***a* and **530***b*. In one embodiment the case **810** is approximately 5.75 inches wide by 6.5 inches deep by 1.6 inches high.

Connectors **730***a* and **730***b* are part of the ACM-to-PCON Interconnection as described earlier in reference to FIGS. **5** and **6**. When the ACM **500** is inserted into the computer bay of a peripheral console (PCON), connectors **730***a* and **730***b* mate with corresponding connectors located at the rear of the computer bay to electrically couple the ACM with the PCON containing the computer bay. Details concerning the ACM-to-PCON Interconnection can be found in the U.S. patent application entitled "A Communication Channel and Interface Devices for Bridging Computer Interface Buses," already incorporated herein by reference. The connectors **730***a* and **730***b* used in one embodiment are connectors complying with the Device Bay industry standard as documented in "Device Bay Interface Specification," revision 0.85, Feb. 6, 1998. Such connectors have specifically been designed to stand up to the rigors of repeated insertion and withdrawal.

Cooling plate **830** forms part of the top surface **812** of ACM **500**. The cooling plate **830** may be mounted to, or project through an opening formed in, case **810**. Similarly, electromagnetic interference (EMI)/electrostatic discharge (ESD) grounding plate **832** forms part of the right surface **814** of ACM **500**. The grounding plate **832** may be mounted to, or project through an opening formed in, case **810**. Cooling plate **830** and grounding plate **832** compressively mate with counterparts when the ACM is fully inserted into the computer bay. The counterparts located along the boundaries of the computer bay conduct dangerous heat and electrical charges away from the ACM. Inside the ACM, cooling plate **830** thermally couples to heat-sensitive components such as CPU **810** by methods well known in the art. Similarly, grounding plate **832** electrically couples to EMI/ESD-sensitive components, such as a microprocessor, by methods well known in the art.

LCD display **850** forms part of the right surface **814** of ACM **500**. The LCD display may be mounted to, or project through an opening formed in, case **810**. The LCD display may contain indicators about the status of the ACM. Such indicators may display, for example, the time-of-day from a time-of-day clock contained within the ACM, or the amount of charge remaining in an ACM-resident battery, or certain configuration options recorded in flash memory. The LCD display **850** provides display capability for a limited amount of information, most useful when the ACM is separated from a PCON (and is thus separated from a full-capability, primary display device).

In one embodiment, the weight of an inserted ACM is largely borne by the bottom side of a computer bay frame. Alternative embodiments are possible where, for example, the weight of the ACM is borne by rails running longitudinally down the right and left sides of the computer bay cavity that engage corresponding grooves running longitudinally down the right and left sides of an ACM.

FIG. **8** illustrates the internal component layout for one embodiment of an ACM. All components are contained within the confines of the ACM case **510**, except for connectors **730***a* and **730***b* which extend from the rear of the ACM **500** to engage mating connectors (not shown) that will couple the ACM circuitry with the PCON circuitry. Main circuit board **910** provides electrical connections for circuitry within the ACM and mounting for many of its components **524**, **522**, **526**, **552**, **542148**, **720**, and **730**. The fabrication and use of such circuits boards is well known and understood in the art. Connector **922** is also mounted on main circuit board **910** and mates with mobile processor module **920**. Mobile processor module **920** represents a form of packaging for a microprocessor and related components. The illustrated mobile processor module **920** is a self-contained unit that includes a microprocessor **512**, CPU cache **514**, and CPU bridge **546** operatively interconnected by the manufacturer. An example of one such module is the Pentium Processor with MMX Technology Mobile Module from Intel Corporation (order number 24 7515-001, September 5997). One skilled in the art recognizes that discrete microprocessor, cache, and bridge could have been employed and mounted directly to the main circuit board.

The mobile processor module **920** blocks the view, from the top, of the system BIOS **524**. Similarly, hard disk drive **532** hides RAM memory **522**, the high performance graphics processor **552**, the host interface controller **720**, and flash memory **526**. Memory upgrade socket **930** remains exposed to facilitate installation of additional RAM memory **522**. Power regulator **542**, like the memory upgrade socket, enjoys a generous amount of overhead clearance to accommodate its vertical size. The area including IDE controller **548** also enjoys overhead clearance to facilitate a cable connection with the hard disk drive **532**.

The functional interconnection and operation of components contained within the ACM and depicted in FIG. **8** has already been described in relation to FIG. **6** for like numbered items appearing therein.

FIG. **7** is a block diagram of a peripheral console (PCON). A peripheral console couples with an ACM to form an operating personal computer system. The peripheral console (PCON) supplies an ACM with primary input, display, and power supply; the ACM supplies the core computing power and environment of the user. In the presently described embodiment the physical PCON package **600** contains the PCON functional components **601** and the PCON side of the ACM-to-PCON Interconnection **700**. The PCON functional components **601** comprise primary display **610**, a primary input **620**, a primary power supply **630**, interface and support **640**, secondary mass storage **650**, other devices **660**, and expansion slots **670**.

The PCON side of the ACM-to-PCON Interconnection **700** comprises a Peripheral Interface Controller (PIC) component **740**, a PCON connector component **750**, console-type component **742**, and flash memory device **748**. The PIC **740** and connector **750** components couple the PCON functional components **201** with the signals of an ACM-to-PCON interface bus **710** used to operatively connect an ACM with a PCON. The ACM-to-PCON interface bus **710** comprises conveyance for electrical power **714** and signals for a peripheral bus **712**, video **716**, video port **717**, and console-type **718**. The preferred ACM-to-PCON Interconnection **700** is described in detail in the U.S. patent application entitled "A Communication Channel and Interface Devices for Bridging Computer Interface Buses," already incorporated herein by reference.

Connector component **750** may be selected to mate directly with the connector component **730** of an ACM (shown in FIG. **6**). Alternatively, connector component **750** may be selected to mate with, for example, the connector on one end of a cable intervening between the PCON and an ACM in a particular embodiment. The ACM-to-PCON interconnection described in the aforementioned companion patent application has the advantage of providing reliable signal conveyance across low cost cables.

Flash memory device **748** provides non-volatile storage. This storage may be accessible to devices in both the ACM and the PCON, including the host interface controller and the peripheral interface controller to which it is connected. As such, flash memory **748** may be used to store configuration and security data to facilitate an intelligent mating between an ACM and a PCON that needs no participation of the CPU.

The primary display component **610** of the PCON functional circuitry **601** of the presently described embodiment comprises integrated display panel **612** and video connector **613**. Integrated display panel **612** is a color LCD display panel having a resolution of 640 horizontal by 480 vertical pixels. 640-by-480 resolution is popularly considered to be the minimum screen size to make practical use of the application software in widespread use today. One skilled in the art recognizes that the type and resolution of the display can vary greatly from embodiment to embodiment, depending on factors such as cost and intended application. Any display device may be used, without departing from the scope and spirit of the invention, that provides principal visual output to the computer user for operating system and application software executing in its customary and intended fashion using the CPU component (**510** of FIG. **3**) of an ACM presently coupled to PCON **600**.

Integrated display panel **612** is coupled to video signal bus **649** and displays a screen image in response to video signals presented on bus **649**. Certain pins of connector **750** receive video output signals **716** of the ACM-to-PCON interface bus **710** from a mated connector that is coupled to an ACM. These certain pins of connector **750** couple to video signal bus **649** which conveys the video output signals **716** throughout the PCON **600** as needed. Video connector **613** is exposed at the exterior of PCON **600** and couples to video signal bus **649**. Connector **613** permits easy attachment of an external display device that is compatible with the signals carried by bus **649**, such as a CRT monitor (not shown). The external display device may be used in addition, or as an alternative, to integrated display panel **612**.

The isolation of the relatively heavy and sizable primary display **610** from the core computing power and user environment contained within an ACM represents a further advantage of the present invention.

The primary input component **620** of the PCON functional circuitry **601** of the presently described embodiment comprises keyboard interface circuitry **622**, keyboard connector **623**, pointer interface circuitry **624**, and pointer connector **625**. Keyboard interface circuitry **622** and pointer interface circuitry **624** connect to ISA bus **645** and are thereby coupled to the CPU component (**510** of FIG. **3**) of any ACM attached to PCON **600**. Keyboard interface circuitry **622** interfaces a standard computer keyboard (not shown), attached at connector **623**, to ISA bus **645**. Pointer interface circuitry **622** interfaces a standard computer pointing device (not shown), such as a computer mouse attached at connector **625**, to ISA bus **645**. Computer keyboards, pointing devices, connectors **623**, **625**, keyboard interface circuitry **622**, and pointer interface circuitry **624** are well known in the art. The isolation of the relatively heavy and sizable primary input devices **620** from the core computing power and user environment contained within an ACM represents a further advantage of the present invention.

The primary power supply component **630** of the PCON functional circuitry **601** of the presently described embodiment provides electrical energy for the sustained, normal operation of the PCON **600** and any ACM coupled to connector **750**. The power supply may be of the switching variety well known in the art that receives electrical energy from an AC source **689**, such as a wall outlet. Power supply **630** reduces the alternating current input voltage, to a number of distinct outputs of differing voltages and current capacities. The outputs of power supply **630** are applied to power bus **631**. Power bus **631** distributes the power supply outputs to the other circuitry within the PCON **600**. Bus **631** also connects to certain pins of connector **350** to provide the electrical power **714** for an ACM conveyed by ACM-to-PCON interconnection **700**. The isolation of the usually heavy power supply **630** from the core computing power and user environment contained within the ACM represents a further advantage of the present invention.

The interface and support component **640** of the PCON functional circuitry **601** of the presently described embodi-

ment comprises peripheral bridge **646**, diskette controller **642**, IDE controller **648**, and signal conveyance paths **641**, **643**, **644**, **645**, **647** and **649**. Peripheral bridge **646** couples PCI peripheral bus **641** with peripheral busses of other formats such as ISA peripheral bus **645** and others **647**. PCI and ISA peripheral busses are industry standards, well known and understood in the art. Other peripheral busses **647** may include, for example, a bus compliant with the universal serial bus (USB) industry standard. While other embodiments of a peripheral console **600** may include a single peripheral bus that is coupled to an attached ACM via ACM-to-PCON interconnection **700**, such as PCI bus **641**, this embodiment includes peripheral bridge **646** to establish additional busses **645**, **647**. The additional busses **645**, **647** permit the use of the many low-cost and readily available components compatible with these bus specifications.

Diskette controller **642** interfaces a floppy disk drive **654** with the CPU component **110** of an attached ACM (shown in FIG. **4**) so that the CPU may control and use the diskette drive **654** hardware to store and retrieve data. Diskette controller **642** couples to the CPU via a connection to ISA bus **645**. Diskette controller **642** connects to the diskette drive **654** via one of device cables **643**.

Similarly, IDE controller **648** interfaces a hard disk drive **652** and a CDROM drive **656** with the CPU component **510** of an attached ACM (shown in FIG. **6**) so that the CPU may control and use the hard disk drive **652** and CDROM **656** hardware to store and retrieve data. IDE controller **648** couples to the CPU via connection to PCI peripheral bus **641**. IDE controller **648** connects to each of hard disk drive **652** and CD-ROM drive **656** via one of device cables **643**. Some embodiments of PCON **600** may take advantage of VLSI integrated circuits such as an 82371 SB (PIIX4) integrated circuit from Intel Corporation. An 82371 SB integrated circuit includes circuitry for both the peripheral bridge **646** and the IDE controller **648** in a single package.

The secondary mass storage component **650** of the PCON functional circuitry **601** of the presently described embodiment comprises diskette drive **654**, hard disk drive **652**, and CD-ROM drive **656**. Secondary mass storage **650** generally provides low-cost, non-volatile storage for data files which may include software program files. Data files stored on secondary mass storage **650** are not part of a computer user's core computing power and environment. Secondary mass storage **650** may be used to store, for example, seldom used software programs, software programs that are used only with companion hardware devices installed in the same peripheral console **600**, or archival copies of data files that are maintained in primary mass storage **550** of an ACM (shown in FIG. **6**). Storage capacities for secondary mass storage **650** devices may vary from the 1.44 megabytes of the 3.5-inch high density diskette drive **654**, to more than 10 gigabytes for a large format (5-inch) hard disk drive **652**. Hard disk drive **652** employs fixed recording media, while diskette drive **654** and CD-ROM drive **656** employ removable media. Diskette drive **654** and hard disk drive **652** support both read and write operations (i.e., data stored on their recording media may be both recalled and modified) while CD-ROM drive **656** supports only read operations.

The other devices component **660** of the PCON functional circuitry **601** of the presently described embodiment comprises a video capture card. A video capture card accepts analog television signals, such as those complying with the NTSC standard used for television broadcast in the United States, and digitizes picture frames represented by the analog signal for processing by the computer. Video capture cards at present are considered a specialty, i.e., not ubiquitous, component of personal computer systems. Digitized picture information from video capture card **660** is carried via signal conveyance path **644** to the peripheral interface controller **740** which transforms it to the video port signals **317** of the ACM-to-PCON interconnection **700** for coupling to the advanced graphics processor **152** in an attached ACM (shown in FIG. **6**).

Video capture card **660** is merely representative of the many types of "other" devices that may be installed in a PCON to expand the capabilities of the personal computer. Sound cards and laboratory data acquisition cards are other examples. Video capture card **660** is shown installed in one of expansion slots **670** for coupling to the interface and control circuitry **640** of the PCON. Any of other devices **660** could be coupled to the interface and control circuitry **640** of the PCON by different means, such as direct installation on the circuit board that includes the interface and control circuitry **640**; e.g., a motherboard.

The expansion slots component **670** of the PCON functional circuitry **601** of the presently described embodiment comprises PCI connectors **671** and ISA connectors **672**. A circuit card may be inserted into one of the connectors **671**, **672** in order to be operatively coupled with the CPU **510** of an attached ACM (shown in FIG. **6**). Each of connectors **671** electrically connects to PCI bus **641**, and may receive and hold a printed circuit card which it electrically couples to PCI bus **641**. Each of connectors **672** electrically connects to ISA bus **645**, and may receive and hold a printed circuit card which it electrically couples to ISA bus **645**. The PCI **641** and ISA **645** busses couple to the CPU **110** of an attached ACM (shown in FIG. **4**) by circuitry already described.

Various modifications to the preferred embodiment can be made without departing from the spirit and scope of the invention. (A limited number of modifications have already been described in the preceding discussion.) For example, a particular embodiment may insert another layer of bus bridging between the CPU bridge and the Peripheral bridge. This may be desirable if, for example, a vendor wants to implement a proprietary, general-purpose bus having intermediate performance characteristics that fall between those of the high-performance general purpose bus originating at the CPU, and the slower general purpose PCI bus. Thus, the foregoing description is not intended to limit the invention as set forth.

While the above is a full description of the specific embodiments, various modifications, alternative constructions and equivalents may be used. Therefore, the above description and illustrations should not be taken as limiting the scope of the present invention which is defined by the appended claims.

What is claimed is:

1. A computer system comprising:

a console comprising a power supply, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing

the coupling sites,

a serial communication controller powered by the power supply,

more than two computer modules; each computer module coupled to one of the coupling site through the connector and the slot, comprising

a second enclosure,

a processing unit,

a main memory coupled to the processing unit, and

a graphics controller;

and a mass storage device coupled to one of the computer modules;

wherein each of the computer modules is substantially similar in design to each other and operates fully independent of each other; and wherein one of the computer modules is configured to provide protection against failure of any one of the other computer modules; and wherein the mass storage device is powered by the console.

2. The computer system of claim **1** wherein each computer module further comprises a communication controller coupled to the serial communication controller in the console adapted to transfer data between any two of the computer modules and to an external network.

3. The computer system of claim **1** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

4. The computer system of claim **1** wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

5. The computer system of claim **1** comprising four or more computer modules.

6. A computer system comprising:

a console comprising a power supply, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being an enclosure housing

the coupling sites,

an Ethernet controller coupled to an external network and powered by the power supply,

more than two computer modules; each computer module coupled to one of the coupling site through the connector and the slot, comprising

a processing unit,

a main memory coupled to the processing unit, and

a network controller coupled to the Ethernet controller through the connector of the coupling site;

and a mass storage device coupled to one of the computer modules;

wherein each of the computer modules is substantially similar in design to each other; and wherein one of the computer modules is configured to provide protection against failure of any one of the other computer modules; and wherein the mass storage device is powered by the console.

7. The computer system of claim **6** wherein the Ethernet controller in the console adapted to transfer data between any two of the computer modules and to an external network.

8. The computer system of claim **6** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

9. The computer system of claim **6** wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

10. The computer system of claim **1** comprising four or more computer modules.

11. A computer system comprising:

a console comprising an Ethernet hub controller, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing

the Ethernet hub controller,

each coupling site,

a plurality of computer modules, each coupled to one of the coupling sites through the connector and the slot; each computer module comprising

a processing unit,

a main memory coupled to the processing unit,

circuitry that can vary the clock frequency of the processing unit for varying its power consumption, and

an Ethernet controller coupled to the Ethernet hub controller through the connector of the coupling site for communication between the computer modules; and

a mass storage device coupled to one of the computer modules;

and wherein each of the computer modules operates fully independent of each other; and wherein one of the computer modules is configured to provide protection against failure of another of the computer modules; and wherein the mass storage device is powered by the console.

12. The computer system of claim **11** wherein the Ethernet hub controller in the console adapted to transfer data between the computer modules and an external network.

13. The computer system of claim **11** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

14. The computer system of claim **11** wherein the computer module's primary input circuitry couples to input devices through the console only.

15. The computer system of claim **11** wherein the computer module further comprises a second enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

16. A computer system comprising:

a console comprising a video switch, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot; the console being a first enclosure housing

each coupling site,

an Ethernet controller coupled to an external network,

a plurality of computer modules; each computer module coupled to one of the coupling sites through the connector and the slot, and comprising

a power supply,

a processing unit,

a main memory coupled to the processing unit, and

a graphics controller coupled to the video switch; and

a mass storage device coupled to one of the computer modules;

wherein each of the computer modules operates fully independent of each other.

17. The computer system of claim **16** wherein the Ethernet controller in the console adapted to transfer data between the computer modules and an external network.

18. The computer system of claim **16** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

19. The computer system of claim **16** wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

20. The computer system of claim **16** wherein the computer module further comprises a second enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

21. A computer system comprising:
a console comprising a video, switch, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot; the console being a first enclosure housing
the video switch,
each coupling site,
an Ethernet hub controller coupled to an external network, and
a plurality of computer modules; each computer module coupled to one of the coupling sites through the connector and the slot, and comprising
a processing unit,
a main memory coupled to the processing unit; and
a graphics controller coupled to the video switch;
wherein each of the computer modules operates fully independent of each other; and wherein one of the computer modules is configured to provide protection against failure of another of the computer modules; and wherein the video output of the graphics controller couples to a display only through the console.

22. The computer system of claim 21 wherein the Ethernet hub controller in the console adapted to transfer data between the computer modules and an external network.

23. The computer system of claim 21 wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

24. The computer system of claim 21 wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

25. The computer system of claim 21 wherein the computer module further comprises a second enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

26. A computer system comprising:
a console comprising an Ethernet hub controller, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing
the Ethernet hub controller,
each coupling site, and
a plurality of computer modules; each computer module coupled to one of the coupling sites through the connector and the slot, and comprising
a processing unit,
a main memory coupled to the processing unit,
a graphics controller,
a mass storage device, and
an Ethernet controller coupled to the Ethernet hub controller through the connector of the coupling site for communication between the computer modules;
wherein each of the computer modules operates independent of each other, and wherein one of the computer modules can replace another one of the computer modules in operation; and wherein the video output of the graphics controller couples to a display only through the console.

27. The computer system of claim 26 wherein each computer module is coupled to a keyboard or a mouse only through the console.

28. The computer system of claim 26 wherein the SCSI hard disk drive is removable while the computer module is in operation.

29. The computer system of claim 26 wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

30. The computer system of claim 26 wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

31. A computer system comprising:
a console comprising an Ethernet controller coupled to an external network, a keyboard/mouse multi-port switch, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being an enclosure housing
the Ethernet controller,
each coupling site, and
more than two computer modules, each coupled to one of the coupling sites through the connector and the slot; each computer module comprising
an enclosure
a power supply,
a processing unit,
a main memory coupled to the processing unit, and
a network controller coupled to the Ethernet controller through the connector of the coupling site for communication between the computer modules;
wherein each of the computer modules operates fully independent of each other; and wherein one of the computer modules is configured to provide protection against failure of any one of the multitude of computer modules; and wherein the computer module couples to a console keyboard based on a command from a user sent to the keyboard/mouse multi-port switch.

32. The computer system of claim 31 wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

33. The computer system of claim 31 wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

34. The computer system of claim 31 comprising four or more computer modules.

35. The computer system of claim 31 wherein the command from the user is in the form of either a key on the keyboard or an icon on the screen that the mouse can click on.

36. A computer system comprising:
a console comprising a keyboard/mouse multi-port switch, a power supply, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being an enclosure housing
each coupling site,
a serial communication controller coupled to an external network and power by the console, and
a plurality of computer modules, each coupled to one of the coupling sites through the connector and the slot; each computer module comprising
a processing unit,
a main memory coupled to the processing unit,
a keyboard input, and
a communication controller coupled to the serial communication controller through the connector of the coupling site for communication between the computer modules;
wherein each of the computer modules operates fully independent of each other; and wherein the keyboard input couples to a keyboard based on a command from a user sent to the keyboard/mouse multi-port switch.

37. The computer system of claim 36 wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

38. The computer system of claim 36 wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

39. The computer system of claim 36 wherein the computer module further comprises of an enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

40. The computer system of claim 36 wherein the command from the user is in the form of either a key on the keyboard or an icon on the screen that the mouse can click on.

41. A computer system comprising:

a console comprising a keyboard/mouse multi-port switch, a video switch coupled to a display, a first coupling site, a second coupling site, each coupling site comprising a connector, the console being a first enclosure that is capable of housing

each coupling site,

a serial communication hub controller coupled to an external network, and

a plurality of computer modules inserted into said console; each computer module coupled to one of the connectors of the console and comprising,

a processing unit,

a communication controller coupled to the serial communication hub controller through the connector of the coupling site to support communication with the other modules,

a main memory coupled to the processing unit, and

a graphics controller coupled to the video switch;

wherein each of the computer modules provide independent processing in the computer system; and wherein one of the computer modules is configured to provide protection against failure of another of the plurality of computer modules.

42. The computer system of claim 41 wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

43. The computer system of claim 41 wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

44. The computer system of claim 41 wherein the computer module further comprises a second enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

45. The computer system of claim 41 wherein the console further comprises a hard disk drive coupled to the computer module.

46. A computer system comprising:

a console comprising a power supply, a universal serial bus (USB), a first coupling site, and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing

each coupling site,

an Ethernet controller powered by the power supply and coupled to an external network,

a plurality of computer modules, each coupled to one of the coupling sites through the connector and the slot; each computer module comprising

a processing unit,

a main memory coupled to the processing unit,

circuitry that can vary the clock frequency of the processing unit for varying its power consumption, and

a network controller coupled to the Ethernet controller through the connector of the coupling site to support communication with the external network;

wherein each of the computer modules operates fully independent of each other; and wherein one of the computer modules can replace another one of the computer modules in operation.

47. The computer system of claim 46 wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

48. The computer system of claim 46 wherein primary input circuitry of the computer module couples to input devices through the console only.

49. The computer system of claim 46 wherein the computer module further comprises a second enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

50. The computer system of claim 46 wherein the console further comprises a video switch.

51. A computer system comprising:

a console comprising an Ethernet hub controller, a universal serial bus (USB), a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing

the Ethernet hub controller,

the coupling sites, and

more than two computer modules; each computer module coupled to one of the coupling site through the connector and the slot, comprising

a processing unit,

a graphics controller,

a main memory coupled to the processing unit, and

an Ethernet controller coupled to the Ethernet hub controller through the connector of the coupling site for communication between the computer modules;

wherein each of the computer modules operates fully independent of each other; and wherein one of the computer modules is configured to provide protection against failure of any one of the multitude of computer modules.

52. The computer system of claim 51 wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

53. The computer system of claim 51 wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

54. The computer system of claim 51 comprising four or more computer modules.

55. The computer system of claim 51 wherein the console further comprises a video switch.

56. A computer system comprising:

a console comprising a video switch, a universal serial bus (USB), a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing

the coupling sites,

an Ethernet hub controller, and

a plurality of computer modules, each coupled to one of the coupling sites through the connector and the slot; each computer module comprising

a processing unit,

a graphics controller coupled to the video switch,

a main memory coupled to the processing unit, and

an Ethernet controller coupled to the Ethernet hub controller for communication between the computer modules;

wherein each of the computer modules operates fully independent of each other.

57. The computer system of claim **56** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

58. The computer system of claim **56** wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

59. The computer system of claim **56** wherein the computer module further comprises of an enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

60. The computer system of claim **56** wherein the console further comprises a hard disk drive coupled to the computer module.

61. A computer system comprising:

a console comprising an Ethernet controller coupled to an external network, a universal serial bus (USB), a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing

a video switch,

each coupling site, and

a plurality of computer modules; each computer module coupled to one of the coupling sites through the connector and the slot; each computer module comprising

a grounding plate for shielding electromagnetic interference (EMI),

a processing unit,

a main memory coupled to the processing unit, and

a graphics controller coupled to the video switch;

wherein each of the computer modules operates fully independent of each other; and wherein the video output of the graphics controller couples to a display only through the console.

62. The computer system of claim **61** wherein primary input circuitry of the computer module couples to input devices through the console only.

63. The computer system of claim **61** wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

64. The computer system of claim **61** wherein the computer module further comprises a second enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

65. The computer system of claim **61** wherein the console further comprises of a hard disk drive coupled to the computer module.

66. A computer system comprising:

a console comprising a universal serial bus (USB), a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing

each coupling site,

a serial communication hub controller, and

a plurality of computer modules; each computer module coupled to one of the coupling sites through the connector and the slot and each computer module comprising

a processing unit,

a main memory coupled to the processing unit,

a SCSI hard disk drive, and

a communication controller coupled to the serial communication hub controller through the connector of the coupling site for communication between the computer modules;

wherein each of the computer modules operates independent of each other.

67. The computer system of claim **66** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

68. The computer system of claim **66** wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

69. The computer system of claim **66** wherein the computer module further comprises a second enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

70. The computer system of claim **66** wherein the console further comprises a hard disk drive coupled to the computer module.

71. A computer system comprising:

a console comprising a universal serial bus (USB), a first coupling site, and a second coupling site, each coupling site comprising a connector and a slot; the console being a first enclosure housing

each coupling site,

a serial communication controller coupled to an external network, and

a plurality of computer modules; each computer module coupled to one of the coupling sites through the connector and the slot and each computer module comprising

a processing unit,

a main memory coupled to the processing unit,

a communication controller coupled to the serial communication controller to support communication with the external network, and

a cooling plate thermally coupled to the processing unit;

wherein each of the computer modules operates fully independent of each other; and wherein one of the computer modules can replace another one of the computer modules in operation.

72. The computer system of claim **71** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

73. The computer system of claim **71** wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

74. The computer system of claim **71** wherein the computer module further comprises of a second enclosure with grooves running down the sides, for engaging with rails running down the computer bay of the console upon insertion.

75. The computer system of claim **71** wherein the console further comprises a hard disk drive coupled to the computer module.

76. A computer system comprising:

a console comprising a video switch, a first coupling site and a second coupling site, each coupling site comprising a connector and a slot, the console being a first enclosure housing

each coupling site,

an Ethernet hub controller, and

a plurality of computer modules; each computer module coupled to one of the coupling sites through the connector and the slot and each computer module comprising

a processing unit,

a main memory coupled to the processing unit,

a cooling plate thermally coupled to the processing unit, and

an Ethernet controller coupled to the Ethernet hub controller through the connector of the coupling site for communication between the computer modules;

wherein each of the computer modules operates fully independent of each other.

77. The computer system of claim **76** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

78. The computer system of claim **76** wherein the computer module further comprises circuitry that can vary the clock frequency of the processing unit for varying its power consumption.

79. A computer system comprising:

a console comprising a power supply, a first coupling site, and a second coupling site, each coupling site comprising a connector and a slot, the console being an enclosure housing

each coupling site,

an Ethernet controller powered by the power supply and coupled to an external network, and

a plurality of computer modules; each computer module coupled to one of the coupling sites through the connector and the slot and each computer module comprising

a processing unit,

a main memory coupled to the processing unit,

primary input circuitry,

circuitry that can vary the clock frequency of the processing unit for varying its power consumption, and

a network controller coupled to the Ethernet controller through the connector of the coupling site to support communication with the external network;

wherein each of the computer modules operates fully independent of each other; and wherein the primary input circuitry couples to input devices through the console only; and wherein one of the computer modules is configured to provide protection against failure of another of the plurality of computer modules.

80. The computer system of claim **79** wherein each computer module further comprises a grounding plate for shielding electromagnetic interference (EMI).

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(12) INTER PARTES REEXAMINATION CERTIFICATE (811th)
United States Patent
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(54) **MULTIPLE MODULE COMPUTER SYSTEM AND METHOD**

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G06F 13/00 (2006.01)

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USPC **710/301**; 709/227; 709/248; 710/313; 710/315; 710/63; 710/72

(58) **Field of Classification Search**
None
See application file for complete search history.

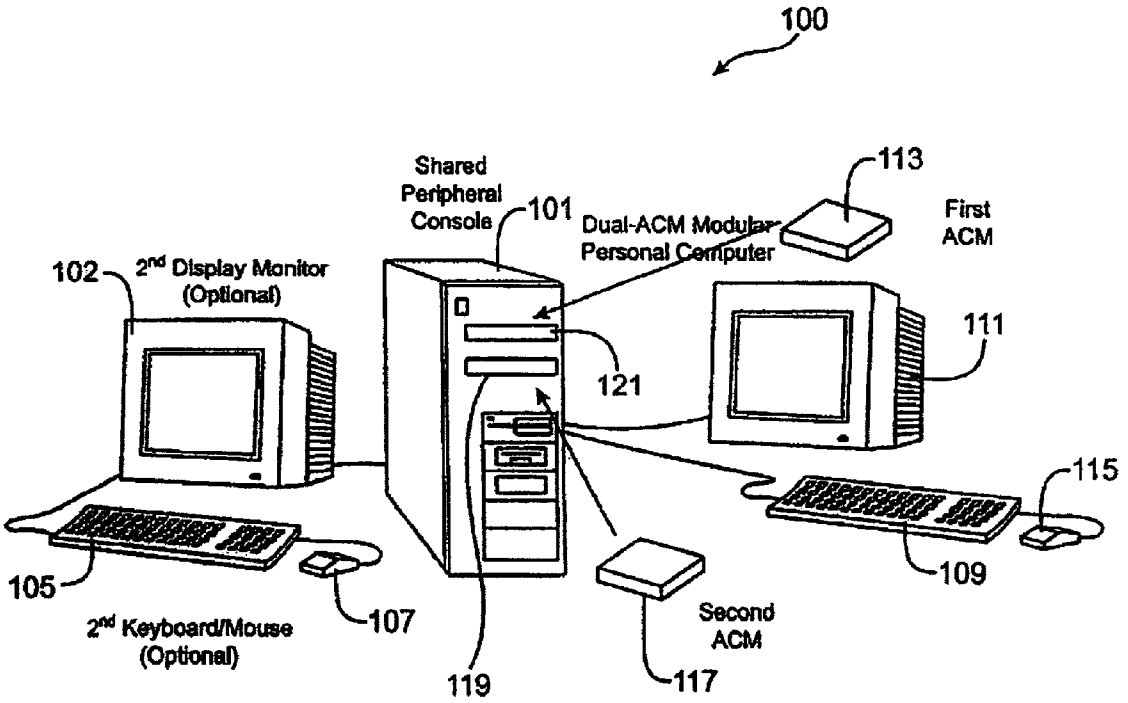
(56) **References Cited**

To view the complete listing of prior art documents cited during the proceeding for Reexamination Control Number 95/001,328, please refer to the USPTO's public Patent Application Information Retrieval (PAIR) system under the Display References tab.

Primary Examiner — Majid A. Banankhah

(57) **ABSTRACT**

A computer system for multi-processing purposes. The computer system has a console comprising a first coupling site and a second coupling site. Each coupling site comprises a connector. The console is an enclosure that is capable of housing each coupling site. The system also has a plurality of computer modules, where each of the computer modules is coupled to a connector. Each of the computer modules has a processing unit, a main memory coupled to the processing unit, a graphics controller coupled to the processing unit, and a mass storage device coupled to the processing unit. Each of the computer modules is substantially similar in design to each other to provide independent processing of each of the computer modules in the computer system.



INTER PARTES REEXAMINATION CERTIFICATE ISSUED UNDER 35 U.S.C. 316

THE PATENT IS HEREBY AMENDED AS INDICATED BELOW.

AS A RESULT OF REEXAMINATION, IT HAS BEEN DETERMINED THAT:

Claims **1-80** are cancelled.

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